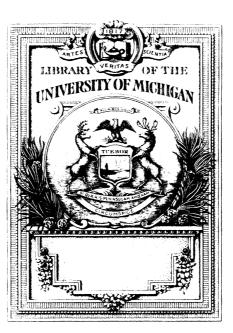
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## THE PHILIPPINE JOURNAL OF SCIENCE

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No. 1

#### THE COMPOSITION OF PHILIPPINE WOODS, VII 1

By F. M. YENKO, LUZ BAENS, and AUGUSTUS P. WEST Of the Bureau of Science, Manila

and

H. M. CURRAN

Of the Bureau of Forestry, Manila

#### EIGHT PLATES

This paper is a continuation of our work on the composition of Philippine (tropical) woods. Six papers have already appeared,<sup>2</sup> and this makes our seventh report.

For a number of years paper has been manufactured from the cellulose in wood. In recent years it has been found that many other commercial products can be made from wood cellulose. Paints, lacquers, plastic articles, artificial leather, rayon, cellophane, and other products are now made from wood cellulose.

Since wood is a very compact raw material, which can be easily obtained and handled, it naturally serves as one of the best sources of industrial cellulose. In addition to cellulose, wood contains other substances—oils, resins, gums, and an inert material known as lignin. In using wood cellulose for commercial purposes these foreign substances are separated from

<sup>&</sup>lt;sup>1</sup>This work is carried on cooperatively by the division of chemical research, Bureau of Science, and the Bureau of Forestry.

<sup>&</sup>lt;sup>2</sup> Yenko, F. M., Luz Baens, A. P. West, and H. M. Curran, Philip. Journ. Sci. 47 (1932) 281 and 343; 48 (1932) 299; 49 (1932) 587; 52 (1933) 209; 53 (1934) 489.

the cellulose, as otherwise they would contaminate and render it unsuitable for many purposes.

For industries that use wood as their basic raw material the composition of woods is a matter of considerable importance.

An account of the general properties of the woods recorded in this paper is given by Schneider.<sup>3</sup> Brief descriptions are as follows:

Bayok-bayókan (*Pterospermum niveum* Vid.) is a tree which grows to a diameter of 60 centimeters. As with other members of this genus the wood is rather tough, hard, and moderately heavy to heavy. It seasons well and is easy to work. Although it is not very durable (durability 4) it is rarely attacked by beetles. The texture is fine and smooth. The wood is used for posts, general construction work, and furniture. Good ties and paving blocks could be made from the wood if impregnated.

Gisok [Shorea balangeran (Korth.) Dyer] reaches a diameter of about 180 centimeters. The wood is hard, tough, heavy and very durable (durability 1). The texture is fine and dense. It is used for high-grade permanent construction, beams, bridges, hubs, spokes, ties, tools, and other purposes.

Salakin [Aphanamixis cumingiana (C. DC.) Harms] reaches a diameter of 50 centimeters. The wood is hard and heavy. The heartwood has a rich red color somewhat like a dark grade of cigar-box cedar. The texture is fine, smooth, and glossy. This wood has a pleasant odor, seasons well, and is easy to work. It has a durability of about 3 and is rarely attacked by beetles.

Terukan (Beilschmiedia glomerata Merr.) is a medium-sized tree. The wood is hard and rather heavy. It seasons fairly well and is easy to plane but rather difficult to saw. It is resistant to termites and other insects but not to decay. According to Mr. L. J. Reyes, wood technologist of the Bureau of Forestry, the wood of terukan resembles that of Cryptocarya.

Dungon-late (Heritiera littoralis Dry.) is a tree that grows to a diameter of 90 centimeters. It has a rather short and generally irregular bole. The wood is hard, tough, and heavy. It has a durability of 1 and is rarely attacked by termites. It is used for piling, posts, ties, paving blocks, ship building, and other purposes. It has been recommended for steamed bent work where strength and durability are required.

<sup>&</sup>lt;sup>8</sup> Bull. P. I. Bur. Forestry 14 (1916).

Lanútan [Polyalthia rumphii (Bl.) Merr.] is a medium-sized forest tree that grows to a diameter of about 30 centimeters. The wood is moderately hard and rather heavy. It seasons fairly well but is attacked by fungus stain. The wood is not very durable as it is susceptible to rot infection and is attacked by termites and other wood borers.

Vidal's lanútan [Bombycidendron vidalianum (Naves) Merr. and Rolfe] grows to a diameter of 40 centimeters. The wood is moderately hard, tough, and moderately heavy, and the texture fine and smooth. It seasons well, is fairly easy to work, and has a durability of 3. It is rarely attacked by beetles. It is used for posts, beams, tools, cabinetwork, and musical instruments, but particularly for shafts of vehicles.

Yakál [Hopea plagata (Blco.) Vid.] is a tall straight tree that grows to a diameter of 100 to 180 centimeters. The wood is very hard, tough, stiff, and very heavy, and the texture fine and dense. The durability is 1. It is used for posts, bridges, wharfs, tools, cabinetwork, ties, paving blocks, and other permanent construction work. The supply is usually abundant.

Akle [Albizzia acle (Blco.) Merr.] grows to a diameter of 125 centimeters or more. It has a short bole that is often crooked. The sapwood is very perishable but the heartwood is durable. The heartwood has a strong peppery odor and the dust from it causes violent sneezing. This wood has a durability of 1 and is practically never attacked by insects. It is used for general construction, furniture, and all kinds of high-grade interior work.

Mahogany (Swietenia mahagoni Jacq.) is a tree that grows to a diameter of about 40 centimeters. The wood is hard and heavy. It seasons well and is easy to saw and plane. It is very durable and resistant to termites and other insects. It is a very good wood for furniture and high-grade interior work.

Malúgai (Pometia pinnata Forst.) grows to a diameter of 100 centimeters. The wood is hard, flexible, tough, and moderately heavy. It bends well when steamed. It seasons well and is fairly easy to work. The durability is 3. The sapwood is commonly attacked by insects and sometimes the damage extends into the heartwood. This wood is used for interior work, boats, tools, furniture, and other purposes.

Teak (*Tectona grandis* L. f.), according to Schneider,<sup>4</sup> is not native to the Philippines but was sparingly introduced so long ago that trees up to 80 centimeters in diameter have been found. It is reported from one or two localities in Luzon, from Cotabato, Zamboanga, Basilan, and the Sulu group. The teak used in the Philippines is imported. Teak is a rather hard wood that is moderately heavy. It seasons well and is very durable and easy to work. It is a very good wood for furniture and highgrade interior work.

Banabá [Lagerstroemia speciosa (L.) Pers.] has wood that is rather hard and heavy. It seasons fairly well and has a durability of 1. It is rarely attacked by termites and is used for various purposes such as paving blocks, general construction, interior finish, and furniture.

Banúyo (Wallaceodendron celebicum Koord.) grows to a diameter of 150 centimeters and has a short bole that is often crooked. The wood is moderately hard and heavy. It seasons very well, is easy to work, and has a durability of 3. The heartwood is rarely attacked by beetles. This wood is used for interior finish, windows, shell screens, furniture, musical instruments, and other purposes.

Bitaog (Calophyllum inophyllum L.) is also known by the Spanish name palomaria, or palomaria de la playa ("of the beach"). This tree reaches a diameter of 130 centimeters but generally has a very short and irregular bole. It is very common and well known and has been reported as growing in practically every Philippine province that has a sea coast. The wood is hard and heavy. The grain is generally curly, wavy, and crossed, making the wood difficult to split. The wood seasons well, has a durability of 2, and is rarely attacked by insects. It is used for posts, flooring, hubs, furniture, and other purposes.

Pahútan (Mangifera altissima Blco.) is one of the mango family of trees. It is a tall tree that grows to a diameter of 80 centimeters. The wood is moderately hard and heavy with a rather fine texture. It seasons well, though large knots sometimes check and the sapwood is liable to stain if not seasoned quickly. It is easy to work and takes a beautiful finish. The durability is 3. This wood is used for various purposes such as beams, door panels, furniture, chests, etc.

<sup>&</sup>lt;sup>4</sup>Bull. P. I. Bur. Forestry 14 (1916) 207.

fpil [Intsia bijuga (Colebr.) O. Ktze.] grows to a diameter of about 180 centimeters. The wood is hard and heavy with a grain that is straight or somewhat crossed. It has a durability of 1 except with regard to teredos. It is used in all high-class general construction, such as beams, ties, tools, agricultural implements, musical instruments, and for other purposes. On account of its hardness, stiffness, and great durability, it is one of the best woods in the Islands.

Lángil [Albizzia lebbeck (L.) Benth.] is a small to mediumsized tree. The wood is hard and heavy, seasons well, and is easy to work. It has a durability of 2 and is rarely attacked by beetles. It is used for posts, ties, agricultural implements, and other purposes.

Liúsin [Parinarium corymbosum (Bl.) Miq.] grows to a diameter of 60 to 90 centimeters and sometimes even larger. The wood is hard and very heavy. The sapwood and heartwood are scarcely distinguishable. This wood is difficult to work as it rapidly dulls all tools. When it is in contact with the ground or exposed to the weather its durability is poor. However, it is rarely attacked by insects and is very resistant to teredos. When impregnated it is suitable for ties and paving blocks. It is a favorite of the charcoal burners of Bataan.

Moláve (Vitex parviflora Juss.) is, excepting narra, the most highly esteemed and most variously used wood in the Philippines. This tree grows to a diameter of 200 centimeters or more and generally has a short, crooked, and fluted bole. The wood is hard, stiff, brittle, and heavy. It is easy to work, perhaps the easiest of all Philippine woods of equal hardness and density. It has a durability of 1 and is rarely attacked by termites. It is employed in all kinds of construction such as piles, beams, ties, flooring, furniture, sculpture, carving, wood-cut engraving, tools, pestles, mortars, and agricultural implements.

Pagsahíngin [Canarium villosum (Bl.) F. Vill.] is probably the largest and most widely distributed species of this genus. It grows to a diameter of 100 centimeters or more. The wood is moderately hard and moderately heavy. It seasons well, is rather easy to work, and is subject to the attacks of beetles; it is used for cheap construction. The durability is 4.

Sibukau (*Caesalpinia sappan* L.) is a small straggling tree that grows to a diameter of 15 to 20 centimeters. It is known from northern Luzon to Mindanao. This wood is practically

identical with the Brazil wood of South America. Its heart-wood is orange-red, and it is employed in making canes and scabbards, and for inlay work.

Talísai (*Terminalia catappa* L.) is a tree of medium height that grows to a diameter of about 75 centimeters. It is found in beach-type forests and is often planted in and about towns. The wood is moderately hard and moderately heavy. It seasons well, is easy to work, and has a durability of 3. Chips soaked in water give a yellow-colored solution. It is used for rafters, flooring, joists, furniture, and other purposes.

Tindalo [Pahudia rhomboidea (Blco.) Prain] is usually a straight tree that grows to a diameter of about 120 centimeters. The wood, which is hard and heavy, seasons well, and is, perhaps, less subject to checking and warping than any other well-known Philippine cabinet wood. It saws smoothly and is not difficult to shape and surface. It has a durability of 2 and is rarely attacked by termites, but it is not very durable in the ground or when exposed to teredos. Tindalo is one of the finest Philippine cabinet woods and is used for all kinds of high-grade construction, interior finish, floors, doors, and windows. It is a favorite for stair steps and hand rails because of its indestructible color and hardness.

In Table 1 are given the measurements of the trees from which samples were taken for our analyses.

In analyzing the wood samples we followed, in general, the methods adopted by the forest products laboratory at Madison, Wisconsin.<sup>5</sup>

Certain details,<sup>6</sup> which we found by previous experience to increase the accuracy of the results, were introduced in the analytical procedures.

#### RESULTS

The results of analyzing the woods recorded in this paper are given in Table 2.

#### SUMMARY

Twenty-four samples of Philippine woods were analyzed and the results recorded in this report. These woods have the fol-

<sup>&</sup>lt;sup>6</sup> Bray, N. W., Paper Trade Journ. 87 No. 25 (1928) 59. Schorger, A. W., Chemistry of Cellulose and Wood (1926) 505.

<sup>&</sup>lt;sup>6</sup> Yenko, F. M., Luz Baens, A. P. West, and H. M. Curran, Philip. Journ. Sci. 47 (1932) 343.

Table 1.—Measurements of trees used for wood analyses.

Name of tree.	Diameter.	Total height.	Clear length of trunk.	Height from which specimen was taken.	
	cm.	m.	m.	m.	
Bayok-bayókan; Pterospermum niveum	15.0	8.40	4.60	2.10	
Gisok; Shorea balangeran a					
Salakin; Aphanamixis cumingiana	12.5	9.70	8.40	0.30	
Terukan; Beilschmiedia glomerata	19.0	12.10	8.00	0.50	
Dufigon-late; Heritiera littoralis					
Lanútan; Polyalthia rumphii	24.0	11.90	5.70	0.50	
Vidal's lanútan; Bombycidendron vidalianum	25.0	15.10	5.40	0.50	
Yakal; Hopea plagata					
Akle; Albizzia acle	13.4	8.01	1.95	1.11	
Mahogany; Swietenia mahagoni	17.1	10.70	2.20	0.10	
Malúgai; Pometia pinnata	29.0	15.80	6.70	6.00	
Teak; Tectona grandis	37.0	17.00	2.80	1.41	
Banabá; Lagerstroemia speciosa	15.2	10.50	1.96	0.83	
Banúyo; Wallaceodendron celebicum	22.5	14.50	3.00	0.55	
Bitaog; Calophyllum inophyllum	86.8	19.32	1.93	8.50	
Pahútan; Mangifera altissima					
fpll; Intsia bijuga	37.4	16.83	1.38	0.68	
Lafigil; Albizzia lebbeck	27.6	16.73	5.00	2.75	
Llúsin; Parinarium corymbosum	16.5	9.59	1.88	0.16	
Moláve; Vitex parviflora	21.3	11.20	4.20	1.18	
Pagsahingin; Canarium villosum	29.7	12.31	2.34	4.33	
Sibukáu; Caesalpinia sappan	9.0	9.00	0.70	0.05	
Talisai; Terminalia catappa	14.7	7.16	4.90	0.73	
Tíndalo; Pahudia rhomboidea	5.8	5.86	1.67	1.28	

<sup>•</sup> These woods were of average mature size. Exact measurements were not made.

lowing common names: Bayok-bayókan, gisok, salakin, terukan, dungon-láte, lanútan, Vidal's lanútan, yakál, akle, mahogany, malúgai, teak, banabá, banúyo, bitaog, pahútan, ípil, langil, liúsin, moláve, pagsahíngin, sibukau, talísai, and tíndalo.

As shown by the data (Table 2) ípil has the highest cellulose content and dungon-láte the lowest. Dungon-láte has the highest lignin and mahogany the lowest. The highest alpha cellulose was given by bayok-bayókan and sibukau gave the lowest. Liúsin has the highest ash content and Vidal's lanútan the lowest.

#### ACKNOWLEDGMENT

The authors wish to thank Mr. Mamerto D. Sulit, of the Philippine Bureau of Forestry, for checking the scientific names of the woods recorded in this paper.

Table 2.—Analysis of Philippine woods.

	***					,
Constituent.	Bayok- bayókan; Pterosper- mum niveum.	Gisok; Shorea balan- geran.	Salakin; Aphana- mixis cumin- giana.	Terukan; Beilsch- miedia glomera- ta.	Duñgon- láte; Heritiera littoralis.	Lanútan; Polyalthia rumphii.
TO SECURE A CASE OF THE PROPERTY OF THE PROPERTY OF THE SECURE ASSESSMENT ASS	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Cold-water soluble	1.79	3.52	3.78	8.06	6.11	5.19
Hot-water soluble	2.18	5.44	7.60	5.50	12.12	11.14
Alkali soluble	12.48	19.24	17.75	16.03	26.72	19.52
Ether extract	1.03	2.74	0.47	0.66	1.97	0.47
Alcohol extract	2.18	4.18	3.07	3.06	7.06	4.69
Ash	0.91	1.14	2.72	1.11	2.45	1.93
Nitrogen	0.32	0.28	0.30	0.38	0.38	0.55
Lignin	32.50	29.51	83.26	24.99	40.03	27.63
Cellulose	55.84	49.46	50.49	45,46	40.66	45.53
Ash (determined) in cel-						
lulose	0.38	0.30	1.48	0.22	0.78	0.24
Cellulose (ash free)	55.46	49.16	49.01	45.24	89.88	45.29
Alpha cellulose in total						l
cellulose	79.20	81.27	79.36	73.17	78.57	73.95
Alpha cellulose in the						
wood	44.23	40.20	40.07	33.26	31.95	33.70
Constituent.	Vidal's lanútan; Bombyci- dendron vidali- anum.	Yakál; Hopea plagata.	Akle; Albizzia acle.	Mahogany; Swietenia mahagoni.	Malúgai; Pometia pinnata.	Teak; Tectona grandis.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Cold-water soluble	0.53	5.92	4.97	7.51	6.74	7.40
Hot-water soluble	2.87	8.96	12.36	11.70	7.65	11.05
Alkalí soluble	13.85	23.67	16.92	19.76	12.50	21.80
Ether extract	0.37					
		6.18	0.91	8.94	0.58	2.81
Alcohol extract					0.58 9.98	
Alcohol extract	2.49 0.45	7.48	0.91 6.77 1.11	8.94 7.35 0.75		8.74
Ash	2.49 0.45	7.48 1.95	6.77 1.11	7.35 0.75	9.98 1.36	8.74 1.74
AshNitrogen	2.49 0.45 0.18	7.48 1.95 0.35	6.77 1.11 0.44	7.35 0.75 0.48	9.98	8.74
Ash Nitrogen Lignin	2.49 0.45	7.48 1.95	6.77 1.11	7.35 0.75	9.98 1.36 0.28 37.29	3.74 1.74 0.35
Ash Nitrogen Lignin Cellulose	2.49 0.45 0.18 29.46	7.48 1.95 0.35 34.21	6.77 1.11 0.44 33.15	7.35 0.75 0.48 24.95	9.98 1.36 0.28	3.74 1.74 0.35 34.83
Ash	2.49 0.45 0.18 29.46	7.48 1.95 0.35 34.21 41.50	6.77 1.11 0.44 33.15	7.35 0.75 0.48 24.95	9.98 1.36 0.28 37.29	3.74 1.74 0.35 34.83
Ash	2.49 0.45 0.18 29.46 56.83	7.48 1.95 0.35 34.21 41.50	6.77 1.11 0.44 33.15 45.75	7.35 0.75 0.48 24.95 49.57	9.98 1.36 0.28 37.29 43.97	3.74 1.74 0.35 34.83 44.95
Ash	2.49 0.45 0.18 29.46 56.83	7.48 1.95 0.35 34.21 41.50	6.77 1.11 0.44 33.15 45.75	7.35 0.76 0.48 24.95 49.57	9.98 1.36 0.28 37.29 43.97	3.74 1.74 0.35 34.83 44.95
Ash	2.49 0.45 0.18 29.46 56.83	7.48 1.95 0.35 34.21 41.50 0.27 41.23	6.77 1.11 0.44 33.15 45.75 0.55 45.20	7.35 0.76 0.48 24.95 49.57 0.27 49.30	9.98 1.36 0.28 37.29 43.97	3.74 1.74 0.35 34.83 44.95
Ash	2.49 0.45 0.18 29.46 56.83	7.48 1.95 0.35 34.21 41.50	6.77 1.11 0.44 33.15 45.75	7.35 0.75 0.48 24.95 49.57	9.98 1.36 0.28 37.29 43.97 0.21 43.76	3.74 1.74 0.35 34.83 44.95 0.49 44.46
Ash	2.49 0.45 0.18 29.46 56.83	7.48 1.95 0.35 34.21 41.50 0.27 41.23	6.77 1.11 0.44 33.15 45.75 0.55 45.20	7.35 0.76 0.48 24.95 49.57 0.27 49.30	9.98 1.36 0.28 37.29 43.97 0.21 43.76	3.74 1.74 0.35 34.83 44.95 0.49 44.46

TABLE 2.—Analysis of Philippine woods—Continued.

Constituent.	Banabá; Lagerstro- emia speciosa.	Banúyo; Wallaceo- dendron celebicum.	Bitaog; Calophyl- lum ino- phyllum.	Pahútan; Mangifera altissima.	Ípil; Intsia bijuga.	Lafigil; Albizzia lebbeck.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Cold-water soluble	2.56	1.20	1.91	2.23	4.82	5.26
Hot-water soluble	8.98	3.90	3.58	5.16	11.00	10.75
Alkali soluble	18.24	13.76	15.54	13.53	22.44	20.63
Ether extract	0.16	1.36	0.35	0.28	1.20	0.46
Alcohol extract	1.80	2.50	4.21	4.66	6.89 -	5.78
Ash	2.27	1.18	0.47	0.65	1.25	0.46
Nitrogen	0.52	0.29	0.18	0.14	0.39	0.39
Lignin	34.90	32.00	38.41	31.23	32.70	27,90
Cellulose	45.73	52.62	48.97	54.07	57.81	49.05
Ash (determined) in cel-					001	
lulose	0.56	0.57	0.18	0.20	0.31	0.20
Cellulose (ash free)	45.17	52.05	48.79	53.87	57.50	48.85
Alpha cellulose in total					000	
cellulose	74.68	75.34	69.69	71.05	71.46	71.46
Alpha cellulose in the						
wood	34.15	39.64	34.13	38.42	41.31	85.05
Constituent.	Liúsin; Parinarium corym- bosum.	Moláve; Vitex par- viflora.	Pagsa- híñgin; Cana- rium villosum.	Sibukáu; Caesal- pinia sappan.	Talísai; Terminalia catappa.	Tíndalo; Pahudia rhom- boidea.
Constituent.	Parinarium corym-	Vitex par-	hingin; Cana- rium	Caesal- pinia	Terminalia	Pahudia rhom- boidea.
Constituent.  Cold-water soluble	Parinarium corym- bosum.	Vitex par- viflora.	hingin; Cana- rium villosum.	Caesal- pinia sappan.	Terminalia eatappa.	Pahudia rhom- boidea.
	Parinarium corym- bosum.  Per cent.	Vitex parviflora.  Per cent.	hingin; Cana- rium villosum. Per cent.	Caesal- pinia sappan. Per cent.	Terminalia catappa.  Per cent.	Pahudia rhom- boidea. Per cent.
Cold-water soluble	Parinarium corym- bosum.  Per cent. 1.46	Vitex parviflora.  Per cent. 0.05	hingin; Cana- rium villosum.  Per cent. 4.10	Caesal- pinia sappan.  Per cent. 5.48	Per cent.	Pahudia rhom- boidea. Per cent. 4.43
Cold-water soluble	Parinarium corym- bosum.  Per cent. 1.46 4.55	Vitex parviflora.  Per cent. 0.05 2.33	hingin; Cana- rium villosum.  Per cent. 4.10 14.61	Caesal- pinia sappan.  Per cent. 5.48 9.47	Per cent. 5.35 11.05	Pahudia rhom-boidea.  Per cent. 4.43 8.34
Cold-water soluble Hot-water soluble Alkali soluble	Parinarium corymbosum.  Per cent. 1.46 4.55 13.41	Vitex par- viflora.  Per cent. 0.05 2.33 6.95	hingin; Canarium villosum. Per cent. 4.10 14.61 29.03	Caesal- pinia sappan.  Per cent. 5.48 9.47 24.03	Per cent. 5.35 11.05 18.61	Pahudia rhom- boidea. Per cent. 4.43 8.34 26.10
Cold-water soluble Hot-water soluble Alkali soluble Ether extract	Parinarium corymbosum.  Per cent. 1.46 4.55 13.41 0.96	Vitex par- vifiora.  Per cent. 0.05 2.33 6.95 0.68	hingin; Cana- rium villosum. Per cent. 4.10 14.61 29.03 0.17	Caesal- pinia sappan.  Per cent. 5.48 9.47 24.03 0.35	Per cent. 5.35 11.05 18.61 0.44	Per cent. 4.43 8.34 26.10 0.51 3.07
Cold-water soluble Hot-water soluble Alkali soluble Ether extract Alcohol extract	Parinarium corymbosum.  Per cent. 1.46 4.55 13.41 0.96 2.51	Vitex par- viftora.  Per cent. 0.05 2.33 6.95 0.68 7.83	hingin; Canarium villosum. Per cent. 4.10 14.61 29.03 0.17 2.32	Per cent. 5.48 9.47 24.03 0.35 7.37	Per cent. 5.35 11.05 18.61 0.44 5.06	Per cent. 4.43 8.34 26.10 0.51 3.07 0.89
Cold-water soluble	Parinarium corymbosum.  Per cent. 1.46 4.55 13.41 0.96 2.51 3.72	Vitex par- viflora.  Per cent. 0.05 2.33 6.95 0.68 7.83 1.56	hingin; Canarium villosum. Per cent. 4.10 14.61 29.03 0.17 2.32 2.08	Caesal- pinia sappan.  Per cent. 5.48 9.47 24.03 0.35 7.37 0.81	Per cent. 5.35 11.05 18.61 0.44 5.06 0.72	Per cent. 4.43 8.34 26.10 0.51 3.07 0.89 0.65
Cold-water soluble	Parinarium corymbosum.  Per cent. 1.46 4.55 13.41 0.96 2.51 3.72 0.29	Vitex par- viflora.  Per cent. 0.05 2.33 6.95 0.68 7.83 1.56 0.43	hiñgin; Canarium villosum.  Per cent. 4.10 14.61 29.03 0.17 2.32 2.08 0.21	Caesal- pinia sappan.  Per cent. 5.48 9.47 24.03 0.35 7.37 0.81 0.45	Per cent. 5, 35 11, 05 18, 61 0, 44 5, 06 0, 72 0, 31	Per cent. 4.43 8.34 26.10 0.51 3.07 0.89
Cold-water soluble	Parinarium corymbosum.  Per cent. 1.46 4.55 13.41 0.96 2.51 3.72 0.29 35.96	Vitex par- visiora.  Per cent. 0.05 2.33 6.95 0.68 7.83 1.56 0.43 38.85	hiñgin; Canarium villosum.  Per cent. 4.10 14.61 29.03 0.17 2.32 2.08 0.21 25.83	Per cent. 5.48 9.47 24.03 0.35 7.37 0.81 0.45 32.00	Per cent. 5.35 11.05 18.61 0.44 5.06 0.72 0.31 32.72	Pahudia rhomboidea.  Per cent. 4.43 8.34 26.10 0.51 3.07 0.89 0.65 25.59
Cold-water soluble Hot-water soluble Alkali soluble Ether extract Alcohol extract Nitrogen Lignin Cellulose	Parinarium corymbosum.  Per cent. 1.46 4.55 13.41 0.96 2.51 3.72 0.29 35.96	Vitex par- visiora.  Per cent. 0.05 2.33 6.95 0.68 7.83 1.56 0.43 38.85	hiñgin; Canarium villosum.  Per cent. 4.10 14.61 29.03 0.17 2.32 2.08 0.21 25.83	Per cent. 5.48 9.47 24.03 0.35 7.37 0.81 0.45 32.00	Per cent. 5.35 11.05 18.61 0.44 5.06 0.72 0.31 32.72	Per cent. 4.43 8.34 26.10 0.51 3.07 0.89 0.65 25.59
Cold-water soluble Hot-water soluble Alkali soluble Ether extract Alcohol extract Ash Nitrogen Lignin Cellulose, Ash (determined) in cel-	Parinarium corymbosum.  Per cent. 1.46 4.55 13.41 0.96 2.51 3.72 0.29 35.96 50.59	Vitex par- viftora.  Per cent. 0.05 2.33 6.95 0.68 7.83 1.56 0.43 38.85 49.54	hingin; Canarium villosum.  Per cent. 4.10 14.61 29.03 0.17 2.32 2.08 0.21 25.83 46.10	Caesal- pinia sappan.  Per cent. 5.48 9.47 24.03 0.35 7.37 0.81 0.45 32.00 45.27	Per cent. 5.35 11.05 18.61 0.44 5.06 0.72 0.31 32.72 44.98	Pahudia rhom- boidea.  Per cent. 4.43 8.34 26.10 0.51 3.07 0.89 0.65 25.59 44.80 0.13
Cold-water soluble Hot-water soluble Alkali soluble Ether extract Alcohol extract Ash Nitrogen Lignin Cellulose Ash (determined) in cellulose	Parinarium corymbosum.  Per cent. 1.46 4.55 13.41 0.96 2.51 3.72 0.29 35.96 50.59	Vitex par- viftora.  Per cent. 0.05 2.33 6.95 0.68 7.83 1.56 0.43 38.85 49.54 0.20	hingin; Canarium villosum.  Per cent. 4.10 14.61 29.03 0.17 2.32 2.08 0.21 25.83 46.10 0.84	Caesal- pinia sappan.  Per cent. 5.48 9.47 24.03 0.35 7.37 0.81 0.45 32.00 45.27	Per cent. 5.35 11.05 18.61 0.44 5.06 0.72 0.31 32.72 44.98 0.28	Pahudia rhom- boidea.  Per cent. 4.43 8.34 26.10 0.51 3.07 0.89 0.65 25.59 44.80
Cold-water soluble Hot-water soluble Alkali soluble Ether extract Alcohol extract Ash Nitrogen Lignin Cellulose, Ash (determined) in cellulose Cellulose (ash free)	Parinarium corymbosum.  Per cent. 1.46 4.55 13.41 0.96 2.51 3.72 0.29 35.96 50.59	Vitex par- viftora.  Per cent. 0.05 2.33 6.95 0.68 7.83 1.56 0.43 38.85 49.54 0.20	hingin; Canarium villosum.  Per cent. 4.10 14.61 29.03 0.17 2.32 2.08 0.21 25.83 46.10 0.84	Caesal- pinia sappan.  Per cent. 5.48 9.47 24.03 0.35 7.37 0.81 0.45 32.00 45.27 0.10 45.17	Per cent. 5.35 11.05 18.61 0.44 5.06 0.72 0.31 32.72 44.98 0.28 44.70	Pahudia rhom- boidea.  Per cent. 4.43 8.34 26.10 0.51 3.07 0.89 0.65 25.59 44.80 0.13 44.67
Cold-water soluble Hot-water soluble Alkali soluble Ether extract Alcohol extract Ash Nitrogen Lignin Cellulose Ash (determined) in cellulose Cellulose (ash free) Alpha cellulose in total	Parinarium corymbosum.  Per cent. 1.46 4.55 13.41 0.96 2.51 3.72 0.29 35.96 50.59 2.27 48.32	Vilex par- viflora.  Per cent. 0.05 2.33 6.95 0.68 7.83 1.56 0.43 38.85 49.54 0.20 49.34	hiñgin; Canarium villosum.  Per cent. 4.10 14.61 29.03 0.17 2.32 2.08 0.21 25.83 46.10 0.84 45.26	Caesal- pinia sappan.  Per cent. 5.48 9.47 24.03 0.35 7.37 0.81 0.45 32.00 45.27	Per cent. 5.35 11.05 18.61 0.44 5.06 0.72 0.31 32.72 44.98 0.28	Pahudia rhom-boidea.  Per cent. 4.43 8.34 26.10 0.51 3.07 0.89 0.65 25.59 44.80

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## **ILLUSTRATIONS**

#### PLATE 1

- Fig. 1. Bayok-bayókan; Pterospermum niveum Vid.
  - 2. Salakin; Aphanamixis cumingiana (C. DC.) Harms.
  - 3. Terukan; Beilschmiedia glomerata Merr.

#### PLATE 2

- Fig. 1. Dungon-láte; Heritiera littoralis Dry.
  - 2. Lanutan; Polyalthia rumphii (Bl.) Merr.
  - Vidal's lanutan; Bombycidendron vidalianum (Naves) Merr. and Rolfe.

#### PLATE 3

- Fig. 1. Yakál; Hopea plagata (Blco.) Vid.
  - 2. Akle; Albizzia acle (Blco.) Merr.
  - 3. Mahogany; Swietenia mahagoni Jacq.

#### PLATE 4

- Fig. 1. Malúgai; Pometia pinnata Forst.
  - 2. Teak; Tectona grandis L. f.
  - 3. Banabá; Lagerstroemia speciosa Pers.

#### PLATE 5

- Fig. 1. Banuyó; Wallaceodendron celebicum Koord.
  - 2. Bitaog; Calophyllum inophyllum L.
  - 3. Pahútan; Mangifera altissima Blco.

#### PLATE 6

- Fig. 1. Liusin; Parinarium corymbosum (Bl.) Miq.
  - 2. Langil; Albizzia lebbeck (L.) Benth.

#### PLATE 7

- Fig. 1. Ipil; Intsia bijuga O. Ktze.
  - 2. Moláve; Vitex parviflora Juss.
  - 3. Pagsahingin; Canarium villosum F.-Vill.

#### PLATE 8

- Fig. 1. Sibukau; Caesalpinia sappan L.
  - 2. Talísai; Terminalia catappa L.
  - 3. Tíndalo; Pahudia rhomboidea (Blco.) Prain.



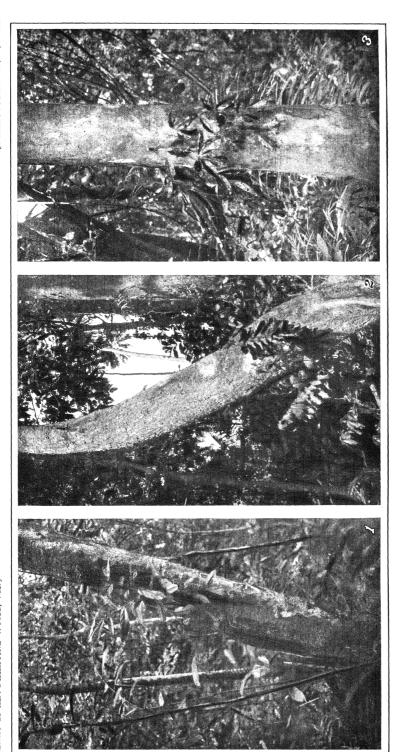
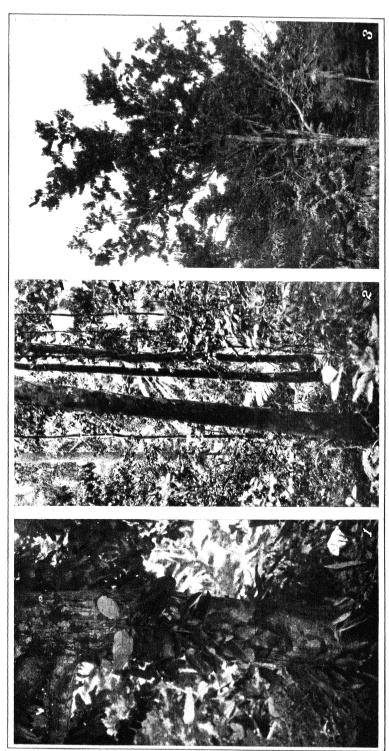
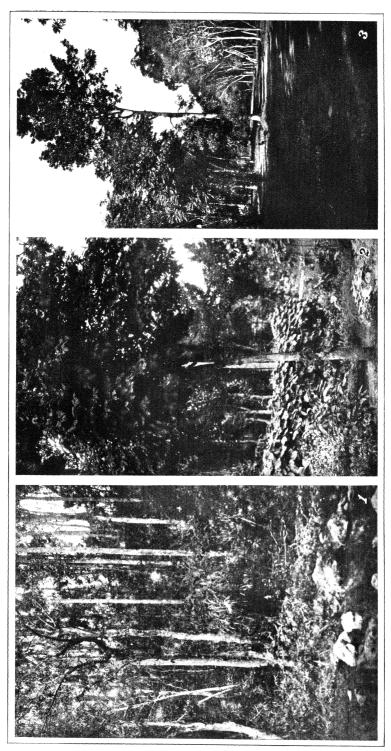


PLATE 1.





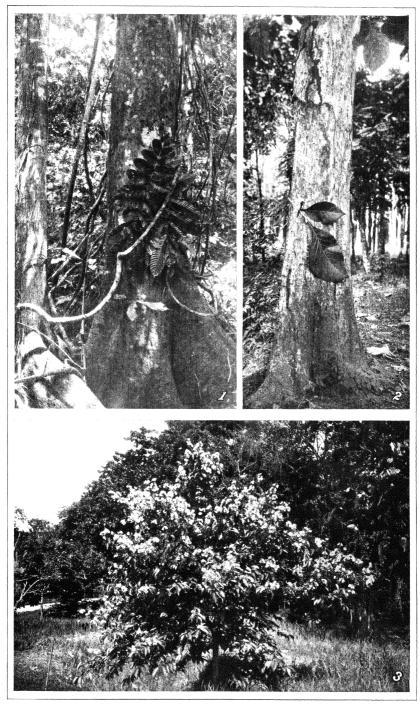
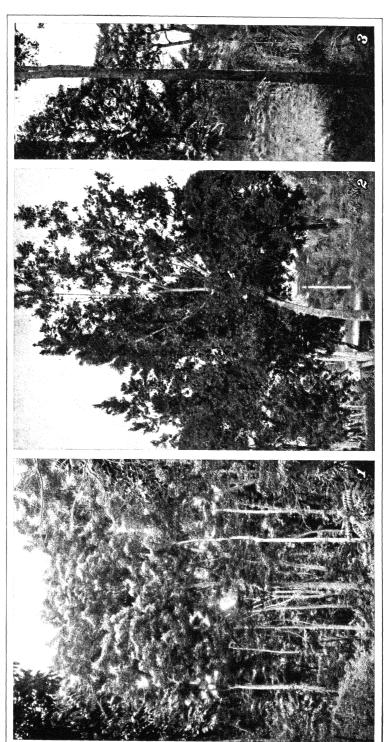


PLATE 4.



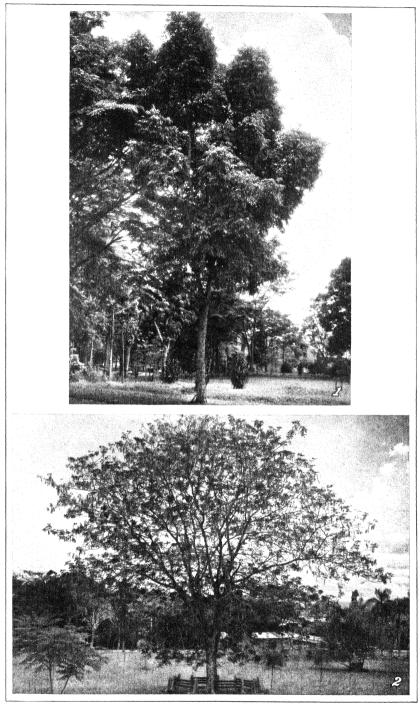


PLATE 6.

PLATE 7.

PLATE 8.

#### THE PHYSIOLOGY OF REPRODUCTION IN SWINE, II

#### SOME OBSERVATIONS ON MATING 1

#### By Agustin Rodolfo

Formerly Geneticist of the All-Union Research Institute for Swine Husbandry, Poltava, Ukraine, U. S. S. R.

This paper is devoted to a study of the mating behavior of swine in the hope that it may add a little to the cumulating knowledge about the biology of this economic animal. The mating behavior of the boar is described, and from the observations made some facts are adduced which throw light on natural insemination in the sow. Attention is focused on the different adaptive means possessed by the boar for depositing the semen during mating. The writer's interest was attracted to this phase of reproductive physiology by studies he was concurrently conducting on the technic of artificial insemination in swine.

#### MATERIALS

The boars upon which these observations were made belong to the batch of experimental animals reported on in the first paper of this series, and the observations were made in the course of the experiments reported in that paper.

#### OBSERVATIONS

(a) The mating behavior of the boar.—Since sows in heat were not always available as decoys, it was necessary to use animals that were not in heat. The sow was tied with a strong rope in a breeding crate so that the boar could mount without her being able to side-step readily. Failure to collect semen at the beginning of the experiment was provisionally explained by the hypothesis that perhaps the sow in heat emitted some sort of an essence which stimulated or excited the boar sexually and in the absence of which the boar would not mate properly. The consideration of a number of facts soon proved this hypo-

<sup>&#</sup>x27;This is the second paper of a series the materials for which were worked out during the writer's stay in Soviet Russia.

thesis untenable. First, as a little practice was obtained the collection of semen from boars that mounted a tied sow not in heat became quite easy. Second, it was later found that the boar will readily mount a dummy sow, which, as a matter of fact, was found to be very convenient to use as decoy. Third, it is a matter of common observation that boars accustomed to living together in the same pen oftentimes mount one another with an accompanying emission of the first two secretions. All these facts tend to show that sexual attraction at most plays only an insignificant rôle in the mating of the boar.

The boar's sexual behavior may be analyzed into relatively simple components. The presence of a sow that does not even have to be in heat, or the presence of a mere dummy sow, constitutes the stimulus to which the boar reacts by mounting. Then, when the boar has assumed the normal mating position, the insertion of the penis into the vagina, or into an artificial vagina—a simple mechanical device possessing warmth (36° to 40° C.), softness, and pulsating pressure—constitutes the other stimulus necessary for the completion of the coitus. It does appear then as if, as far as the boar is concerned, coitus is largely a mechanical process.

For the boar to give the full ejection, the penis must receive warmth, and, just as important, a gentle pulsating pressure. If the artificial vagina is too short, say only 24 cm long, as was the first instrument I had been using, the distal end of the penis often gets beyond the vaginal wall into the bottle, the semen container, a space lacking both the necessary warmth and pressure—the penis sometimes gets as deep as 35 cm. (For a description of the vagina and its construction see the first paper of this series.) As soon as this happens, the boar withdraws the penis entirely and becomes nervous; often he dismounts to begin the mating act all over again. There are some boars, however, that are not disturbed by the lack of both pressure and warmth on the distal end of the penis. These boars are interesting because they give some information on how the semen is deposited during natural insemination.

If the penis is properly lodged, ejection immediately follows. The first two secretions accompany the insertion of the penis into the vagina; as a matter of fact, these two secretions are sometimes squirted even without the penis getting in contact with anything. These first two secretions are composed of a translucent substance coagulated into relatively small masses, and a

straw-colored viscous liquid. The milky spermatozoa-bearing ejection soon follows. The manner in which ejection takes place may be observed with boars that are not disturbed by the distal end of the penis getting beyond the wall of the artificial vagina where warmth and pulsating pressure are lacking. A study of the movements of the penis of such a boar, when it gets beyond the walls of the artificial vagina into the glass semen container, allows the making of the following observations:

The distal end of the penis rotates forward in a counterclock-wise, lefthand screw manner, and the milky ejection is given off at the end of this motion. After the semen is squirted, the distal end of the penis is withdrawn a little, rotating clockwise. These two motions are repeated alternatingly until apparently all of the spermatozoa-laden secretion has been ejected. After the ejection of the milky secretion the glans is retracted and held at rest while a straw-colored ejection is given off profusely. It seems as though this straw-colored ejection, apparently one of the first two secretions noted above, constituted the bulk of the semen.

That the first two secretions are given off profusely is also seen from the fact that when the penis is not properly lodged the boar may continue to jerk back and forth violently, meanwhile squirting the first secretions. In each of four notable instances more than two hundred cubic centimeters of alkaline secretions without spermatozoa were collected from three different boars. Boar No. 2196/87 on June 6, 1931, gave 200 cc, and on June 16, 345 cc of this straw-colored viscous secretion. Neither lot of samples contained spermatozoa, and both were alkaline with pH = 7.9. Boar No. 2200/91, on June 6, 1931, gave 425 cc of secretions without spermatozoa. This had a pH of 8.1. Boar 2695/178 gave, on June 22, 1931, 289 cc of alkaline secretions; pH = 8.1. All the pH determinations were made colorimetrically.

The above data permit of no doubt that the first two secretions are given off in profuse amounts, and strongly suggest that these secretions constitute the bulk of the semen.

(c) Natural insemination.—A clear understanding of the processes taking place in natural insemination is needed for the effective study of the problems pertaining to artificial insemination. In order to facilitate a better understanding of the various adaptations possessed by the boar for depositing the

semen into the uterus, some measurements made on the different parts of the sexual organs of the sow are given in Table 1.

TABLE 1.—Length of	of the	different	parts	of	the	genital	system	of	the	sow.
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Organ.	Number measured.	Average length.
Vestibule	26	cm. 10.3
Sphincter Vagina	26	14.2
Uterus:  Cervix	26	19.2
Cornua: RightLeft.	26 26	129.1 128.3
Fallopian tubes: Right	25	26.4
Left	25	26.6

The above measurements show that the genital tract of the sow assumes relatively long proportions.

The length of the cornua, which constitutes the longest part of the tract, varies widely. Even among the small number of measurements that this writer made, a variation ranging from 85 cm to 205 cm has been observed.

When the sow is not in heat, the opening from the vestibule into the vagina is closed by the sphincter, which seems to relax only during estrum. At least it is impossible to insert readily into the vagina a catheter of about the same thickness as the boar's penis during anæstrum. The cervix of the uterus, because of its rugate thick wall, has a very narrow and crooked canal which the penis probably could not penetrate much farther than the large rugæ at the entrance.

The extraordinary length of the genital tract of the sow and the presence of obstructions, such as the sphincter and the rugate thick-walled cervix, call for special adaptations on the part of the boar for the deposition of the semen in a manner such that the spermatozoa may easily be carried into the Fallopian tubes where fertilization probably takes place. And what are these adaptations?

The first of these adaptations is the lefthand-corkscrewshaped distal end of the penis. From observations made with boars ejecting into a short artificial vagina, a picture of what takes place in natural mating may be inferred. Prior to the ejection of the spermatozoa-laden milky fluid, the penis moves forward in a counter-clockwise manner. This counter-clockwise motion is doubtless a means to enable the lefthand-corkscrew-shaped distal end of the penis to penetrate as deeply as possible into the thick-walled cervix, probably a little beyond the large rugæ at the entrance, before the spermatozoa-laden liquid is ejected. In some boars the penis continues to move counter-clockwise and clockwise alternatingly during the ejection of the spermatozoa-bearing secretion; that is, it is thrust, retracted a little, and then thrust again, until the ejection of the spermatozoa-laden secretion has been completed. This first adaptation, therefore, may constitute a means of depositing the spermatozoa-bearing secretion directly into the cervix of the uterus.

The second adaptation is the large volume of the semen. As was pointed out in the first paper of this series,<sup>2</sup> the average volume of the semen of a lightly mated boar is 254.8 cc. It was also noted that this amount may be as large as 540 cc.

After the ejection of the milky spermatozoa-laden secretion, the distal end of the penis is probably retracted 5 to 10 cm into the vagina proper, and while remaining quite still it gives off considerable quantities of what appear to be of the first two secretions. It was noted above that these two secretions, especially the one given off after the spermatozoa-bearing ejection, are secreted profusely, as much as 425 cc having been collected at one time. Now, what are some of the functions of these two secretions?

The first two secretions are given off at the beginning of the coitus apparently to act as lubricant for the penis and to neutralize any acid reaction that may be present in the vagina and uterus. It will be recalled that these secretions are distinctly alkaline. After the ejection of the spermatozoa-bearing fluid at least one of these secretions, if not both, gives volume to the sperm, enabling it to flow down the long cornua into the Fallopian tubes. Because of the extraordinary length of the cornua, it is necessary for the semen to have a large volume if it is to reach the Fallopian tubes; a small volume is easily dissipated by being adsorbed by the walls of the cornua before it can flow very far. A large volume of semen is, therefore, really an important adaptive factor to insure fertilization.

<sup>&</sup>lt;sup>2</sup> Philip. Journ. Sci. 53 (1934) 183-205.

This author has some data which show that the spermatozoa get into the Fallopian tubes within 40 minutes after a sow in heat was artificially inseminated. In getting there they had to traverse about 20 cm of cervix and 140 cm of cornus. It is apparent that without the aid of the pressure due to the volume of the semen, the spermatozoa by themselves cannot wiggle their way through 160 cm within 40 minutes.

The third adaptation is the vaginal plug or "bouchon vaginal." This is a coagulated, sticky, tough, mucinous white substance, usually the last secretion of the boar during the sexual act. The fact that in experimental work the plug is generally found sticking quite closely to the walls of the artificial vagina, precludes any suggestion of it being a female product, or that the vagina has anything to do with its formation. The voluminous amount of the semen undoubtedly causes the development of a relatively large pressure within the genital tract. The pressure in turn produces a tendency to outflow, and the vaginal plug probably plays a very important rôle in preventing such an outflow and in forcing the semen to flow towards the Fallopian tubes instead.

#### SUMMARY

- 1. It has been pointed out that sexual attraction plays an insignificant rôle in the mating behavior of the boar. For complete ejection a dummy sow and a properly prepared artificial vagina are needed.
- 2. Measurements are given of the genital tract of the sow. The average length of the two cornua and Fallopian tubes, and the cervix, vagina, and vestibule combined, amounts to 354.1 cm, or about 3.5 meters.
- 3. The adaptations possessed by the boar for so depositing the semen into the long genital tract that fertilization will be insured have been analyzed. These are:
- (a) The ejection of the semen directly into the cervix of the uterus by means of the lefthand-corkscrew-shaped glans moving forward in a lefthand-screw manner.
  - (b) The large volume of the semen.
- (c) The presence of the vaginal plug which prevents an outward flow of the semen.

# NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXI¹

By CHARLES P. ALEXANDER
Of Amherst, Massachusetts
THREE PLATES

The crane flies discussed at this time are chiefly from Formosa, where the majority were taken by Prof. Syûti Issiki, to whom I am greatly indebted for the privilege of retaining the material. Other Formosan species described here were taken in 1932 by Prof. Teiso Esaki; the types of such specimens are preserved in the Entomological Museum, Kiushiu Imperial Uni-A third important source of specimens is included in a series taken in the Diamond Mountains (Kongo San, Keumkang San), of Korea, by Prof. Jiro Machida, together with fewer specimens taken by the same scientist in Formosa and Honshiu; these specimens are in my own collection, through the kindly interest of Professor Machida. Other species from Korea that are discussed here and in the succeedings part under this general title, were taken by Prof. Jujiro Masaki and his colleagues, Messrs. I. Tabashi and C. Takeya; the 1930 and earlier collections from Masaki are in my collection, with duplicate numbers in the Agricultural Experiment Station of Chosen, at Suigen; the 1931 and later collections were sent to Professor Esaki and thence to me, the types being returned to Esaki, with duplicate numbers in my collection and at Suigen. I express my continued gratitude to all of the above-mentioned entomologists for this further cooperation in making known the tipulid fauna of the Japanese Empire.

The Issiki collections made in the mountains of southern Formosa have resulted in adding three subgeneric groups of Tipulidæ to those known from Japan and Formosa; namely, *Trichotipula* Alexander, *Dolichopeza* Curtis, s. s., and *Mitopeza* Edwards, as well as two others, *Elliptera* Schiner and *Helobia* St. Fargeau, to the known fauna of Formosa. Several other Pa-

<sup>&</sup>lt;sup>1</sup> Contribution from the entomological laboratory, Massachusetts State College.

læarctic groups were likewise discovered in southern Formosa, south of the Tropic of Cancer, in these cases representing the most southerly distribution in eastern Asia; such additional groups are *Dictenidia* Brullé, *Dicranoptycha* Osten Sacken, *Rhaphidolabis* Osten Sacken, and *Ormosia* Rondani.

In order to complete the record, I have included one species of *Trichocera*, of the family Trichoceridæ.

#### TRICHOCERIDÆ

TRICHOCERA MIRABILIS sp. nov. Plate 1, fig. 1; Plate 2, fig. 25.

Size large (wing, over 8 millimeters); general coloration dark brown, sparsely dusted with grayish yellow pollen; anterior pleurites brownish black, the posterior ones paler; femora brownish yellow, the tips narrowly dark brown; wings brownish yellow, the prearcular region pale yellow; stigma pale brown; very restricted dark clouds on r-m and m-cu; abdomen dark brown; male hypopygium with the tergite produced medially into a narrow darkened lobe, its apex truncated; dististyle elongate, with a long lobe near base and a second pale lobule at near two-thirds the length.

Male.—Length, about 8 millimeters; wing, 8.5.

Female.—Length, about 7.5 millimeters; wing, 8.5.

Rostrum dark gray; palpi black. Antennæ with scape and pedicel light brown; basal flagellar segment dark brown, remainder of flagellum black. Head gray.

Mesonotal præscutum and scutum chiefly dark brown, sparsely dusted with grayish yellow pollen; scutellum somewhat paler, especially the posterior border which is obscure yellow: mediotergite brown. Pleura with propleura, anepisternum, sternopleurite, and ventral meron brownish black, the posterior sclerites paler brown. Halteres elongate, yellow, the slender knobs dusky. Legs with the fore coxæ brownish black, the remaining coxæ and all trochanters brownish yellow; femora obscure brownish yellow, clearer yellow basally, the tips narrowly dark brown; tibiæ brownish black, the tips narrowly darker; tarsi black. Wings (Plate 1, fig. 1) with a brownish yellow tinge, the prearcular region pale yellow; stigma pale brown; very restricted dark clouds on r-m and m-cu more evident in female; veins brown, brighter in the prearcular field. Macrotrichia of veins long and conspicuous, including series on the crossveins m and m-cu. Venation:  $Sc_1$  ending just before  $R_2$ ;  $R_{2+3+4}$  a little shorter than  $R_{2+3}$ ; m-cu at or just before outer end of cell 1st M<sub>2</sub>.

Abdomen dark brown, hypopygium more yellowish. Male hypopygium (Plate 2, fig. 25) with the tergite, 9t, narrowly transverse, the median area produced into a slender darkened lobe, its apex truncate. Basistyle, b, with mesal lobe small, basal in position. Dististyle, d, elongate, near base on mesal face with a slender lobe that is about two-fifths the length of entire style, its apex a little expanded and provided with abundant setulæ; main axis of style at near two-thirds the length with an oval pale lobule set with several long setæ; apical third of style a clavate structure that is fringed with abundant strong spinous setæ on outer face of distal half. Gonapophyses, g, conspicuous, long and slender, gently curved. Ovipositor with cerci elongate, yellowish horn color.

Habitat.—Korea.

Holotype, male, Kongo San, October 18, 1933 (Machida). Allotopotype, female, October 8, 1933 (Machida).

This rather remarkable fly needs no comparison with any other described species of the genus. In its large size it approaches the stature of the genus *Diazosma* Bergroth but is a true *Trichocera*. The structure of the male hypopygium is unusually complicated, suggesting in some respects *T. lutea* Becher (Western Palæarctic) and *T. salmani* Alexander (Eastern Nearctic), yet is very different in all details.

## TIPULIDÆ

#### TIPULINÆ

DICTENIDIA INÆQUIPECTINATA sp. nov. Plate 1, fig. 2.

Head brownish yellow; antennæ (male) very long, with long unequal branches, the longest fully three times as long as the segments; mesonotal præscutum with three black stripes; pleura yellow, unmarked; tips of femora blackened; posterior femora with a narrow yellow subterminal ring; posterior tibiæ chiefly dirty white, only the narrow bases and tips darkened; wings tinged with yellow, the stigma and cord restrictedly seamed with brown; wing tip undarkened and without macrotrichia in the cells; abdominal segments one to five yellow, the tergites with an interrupted black dorsal stripe, segments six to nine black.

*Male.*—Length, about 11 millimeters; wing, 12; antenna, about 5.5.

Frontal prolongation of head yellow, with coarse black setæ, especially on nasal region; palpi brownish yellow, the terminal

segments dark brown. Antennæ elongate, approximately one-half as long as entire body; scape pale yellow; pedicel a trifle darker; flagellar segments bicolorous, the axis and branches dark brown, the outer end of axis of individual segments pale yellow, on outer two segments uniformly darkened; basal flagellar branches elongate, the longest (about flagellar segments seven to nine) fully three times the segments; apical flagellar branches long and slender but conspicuously thinner and shorter than the basal branches of the same segment; in formosana both branches are subequal in length and the outer one is only a trifle slenderer than the basal one; terminal segment elongate, fully one-half longer than the penultimate. Head yellow, with a faint brown tinge, but quite immaculate.

Mesonotal præscutum yellow, with three Pronotum yellow. intensely black stripes that are very slightly covered with delicate yellow setulæ to appear like a bloom; scutal lobes similarly blackened; scutellum dark brown, the parascutella pale; mediotergite pale reddish yellow. Pleura yellow. Halteres yellow, the knobs weakly infuscated. Legs with the coxæ and trochanters yellow; fore and middle femora brownish yellow, the tips broadly and conspicuously blackened, the bases narrowly clearer yellow; posterior femora more enlarged and with a narrow, clearer yellow ring before the blackened tips and about onehalf as wide as the latter; fore and middle tibiæ almost uniformly blackened; posterior tibiæ narrowly blackened at base, the amount subequal to the dark femoral tips, the apices similarly narrowly darkened, the entire intermediate portion, embracing more than five-sixth of the segment, dirty white; tarsi Wings (Plate 1, fig. 2) tinged with yellow, the prearcular region and cells C, Sc, and Cu, clearer yellow; stigma oval, brown; a slightly paler brown cloud on anterior cord and a very narrow seam on m-cu; wing tip undarkened; veins brown, more vellow in the flavous areas. No macrotrichia in apical cells of wing, as is the case in all other members of the genus. Venation:  $Sc_1$  indicated by a weak spur;  $M_{3+4}$  a little more than one-half m; petiole of cell M<sub>1</sub> a little shorter than m.

Abdominal tergites one to five obscure yellow, narrowly blackened medially, the caudal borders of the intermediate segments broadly grayish white; sternites one to five similarly obscure yellow; segments six to nine, with all appendages, intense black; vestiture of hypopygium black, of remainder of abdomen, yellow.

Habitat.—Formosa.

Holotype, male, Kanshirei, altitude 1,500 feet, May 13, 1933 (*Issiki*). Paratypes, 2 males, Arisan, June 6, 1932 (*Gressitt*).

Dictenidia inæquipectinata is so different from all other described species of the genus that it scarcely requires comparison with any. The lack of macrotrichia in the wing cells and the unusually long antennæ of the male, with very long unequal branches, are the most conspicuous specific characters. Dictenidia sauteri Enderlein² is at most a color variety of D. formosana Alexander.³

#### DOLICHOPEZA (DOLICHOPEZA) ISSIKIELLA sp. nov. Plate 1, fig. 3.

Mesonotum dark reddish brown, variegated with more grayish brown; legs very long; posterior tibiæ and tarsi entirely snowy white; central portion of anterior tibiæ and proximal ends of basitarsi more darkened; wings strongly infumed, the large stigma even darker brown; conspicuous cream-colored areas before and beyond stigma; Rs short, its origin opposite termination of Sc<sub>2</sub>; abdominal segments conspicuously variegated with brownish yellow, dark brown, and silvery white.

Female.—Length, about 14 millimeters; wing, 11.5.

Frontal prolongation of head brownish black; palpi black. Antennæ with scape and pedicel light yellow, flagellum brownish black; flagellar segments cylindrical, with short verticils. Head behind gray, the front more silvery; a capillary brown vitta extends from the region of the vertical tubercle almost to occiput; anterior vertex wide, approximately five times the diameter of scape.

Mesonotal præscutum with the ground color on sides dark reddish brown, the lateral stripes slightly differentiated by a sparse pruinosity; intermediate stripes more pruinose on anterior ends, behind concolorous with the lateral margins; humeral region and anterior interspaces very restrictedly light gray; scutum dark reddish brown; scutellum dark brown medially, the posterior lateral portions broadly yellow, the parascutella reddish brown; mediotergite dark brown, the lateral borders somewhat paler. Pleura variegated dark brown and testaceous, the pale color including chiefly the pteropleurite and meral region. Halteres with stem obscure whitish, the extreme base brighter, the knobs dark brown. Legs with the fore coxæ chiefly dark brown, the other coxæ darkened basally with the tips broadly pale; trochanters whitish; femora dirty brownish white, the tips

<sup>&</sup>lt;sup>a</sup> Zool, Anzeig. 52 (1921) 225-226.

<sup>&</sup>lt;sup>a</sup> Ann. Ent. Soc. Am. 13 (1920) 261-262.

insensibly darkened; posterior tibiæ and tarsi entirely snowy white; remaining legs detached, but one pair shows the extensive central portion of tibiæ pale brown, the bases somewhat narrowly, the tips broadly snowy white; tarsi snowy white, the proximal ends of basitarsi slightly darkened; legs unusually long and slender. Wings (Plate 1, fig. 3) with the ground color very strongly infumed, the costal region and narrow apical border to opposite vein  $Cu_1$  even more darkened; stigma large, oval, dark brown; conspicuous cream-colored obliterative areas before and beyond stigma; veins dark brown. Venation: Rs short, in oblique to subtransverse alignment with the basal section of  $R_{4+5}$  and only a little longer than this element;  $Sc_2$  ending exactly opposite origin of Rs;  $R_{1+2}$  entirely atrophied; medial forks of moderate depth; m-cu at fork of M.

Abdominal segments conspicuously variegated with brownish yellow, dark brown, and silvery white, the narrow darker rings occupying the central and apical portions of the individual segments; lateral borders of tergites and posterior portions of intermediate sternites variegated with silvery white areas; outer tergites and genital shield chiefly blackened. Cerci elongate.

Habitat.—Formosa.

Holotype, female, Kanshirei, altitude 1,500 feet, May 13, 1933 (*Issiki*).

I take great pleasure in naming this fine species in honor of the collector of this series of Tipulidæ, my friend, Prof. Syûti Issiki. The species is of great interest in being the first true member of the subgenus Dolichopeza to be discovered in continental Asia or the Indo-Malayan islands. The subgeneric position of Dolichopeza postica Brunetti is still questionable, but from the rather remarkable venation of the medial field of the wing it does not seem to be strictly referable to the subgenus Dolichopeza. Similarly the three Philippine members of the malagasya group (ata Alexander, isolata Alexander, and bilan Alexander) are by no means typical members of the subgenus, though placed therein provisionally. The present fly bears a superficial resemblance to D. (Nesopeza) albitibia Alexander, but the subgeneric characters will readily serve to distinguish the two.

## DOLICHOPEZA (MITOPEZA) TAIWANICOLA sp. nov. Plate 1, fig. 4.

General coloration of mesonotum dark brown, with four paler brown stripes; knobs of halteres at tips conspicuously yellow; tibiæ and tarsi uniformly black; wings rather strongly tinged with brown, the stigma darker; restricted cream-colored areas before and beyond stigma and across base of cell 1st  $M_2$ ; sparse macrotrichia in distal ends of outer radial and medial cells;  $Sc_2$  ending opposite origin of the short Rs;  $R_{1+2}$  represented as a short spur; cell  $M_1$  long-petiolate; cell 1st  $M_2$  very small, lying in fork of veins  $M_{1+2}$  and  $M_3$ ; m-cu more than one-half its length before fork of M; abdominal tergites brown, the caudal borders narrowly blackened.

Female.—Length, about 8.5 millimeters; wing, 11.2.

Frontal prolongation of head testaceous-yellow; region of nasus tufted with three or four long black setæ; palpi black. Antennæ with scape and pedicel light yellow; flagellum brownish black, the flagellar verticils approximately equal in length to the segments. Front light yellow, the vertex brown; anterior vertex approximately five times as wide as diameter of scape.

Ground color of mesonotal præscutum dark brown, with four paler brown stripes, the intermediate pair narrow, tapering behind, separated by a dark median gray line that is nearly equal in width to the stripes; posterior sclerites of notum dark brown. Pleura obscure brownish yellow, the propleura and anepisternum darker brown; dorsopleural membrane extensive, dark brown. Halteres pale yellow, the bases of knobs brownish black, the apices broadly and conspicuously light yellow. Legs with the coxæ dark brown; trochanters testaceous-brown; femora dark brown, the tips passing into black; tibiæ and tarsi black; legs of moderate length only. Wings (Plate 1, fig. 4) with a rather strong brown tinge, cells C and Sc very slightly darker; stigma oval: dark brown; restricted but conspicuous cream-colored areas before and beyond stigma and across the base of cell 1st M<sub>2</sub>; wing tip as far back as vein Cu<sub>1</sub> narrowly darkened; Cu, 2d A, and most of the longitudinal veins beyond cord very narrowly and insensibly seamed with darker; veins brownish black. Sparse macrotrichia in outer ends of cells  $Sc_2+R_2$ ,  $R_3$ ,  $R_5$ ,  $M_1$ , and 2d M<sub>2</sub>. Venation: Sc<sub>2</sub> ending opposite origin of the short Rs;  $R_1$  meeting  $R_2$  at an angle, with  $R_{1+2}$  projecting beyond this point as a short spur; cell 1st M<sub>2</sub> very small, a little widened outwardly; petiole of cell M<sub>1</sub> elongate, subequal to m-cu; m-cu more than one-half its length before fork of M, M, branching off some distance before base of cell 1st M2.

Abdominal tergites brown, the caudal borders of the segments narrowly blackened; sternites obscure yellow, the caudal borders narrowly darkened. Ovipositor with small blunt valves, as in subgenus.

Habitat.—Southern Formosa.

Holotype, female, Keinensan, altitude 5,400 feet, August 14, 1933 (*Issiki*).

Dolichopeza (Mitopeza) taiwanicola is very different from the other described members of the subgenus in the short, oblique Rs, with Sc<sub>2</sub> ending opposite its origin. By my key to the subgenera of Dolichopeza <sup>4</sup> the species runs to couplet 3, including Mitopeza, but disagrees in the character of the short sector. By my further key to the species of Mitopeza, <sup>5</sup> the present fly runs to the subgenotype, nitidirostris (Edwards), a very different insect whose wing has been figured by Edwards. The latter fly has the long Sc and Rs, together with cell 1st M<sub>2</sub> large and cell M<sub>1</sub> entirely sessile. The subgenus is new to the fauna of Formosa and the Japanese Empire.

## TIPULA (TRICHOTIPULA) HAPLOTRICHA sp. nov. Plate 1, fig. 5; Plate 2, fig. 26.

General coloration black, including the entire thorax, the pleura slightly pruinose; antennæ black, moderately long (male); legs black; wings with a strong brownish yellow tinge; stigma oval, dark brown; abundant macrotrichia in cells beyond cord, with the exception of 1st M<sub>2</sub>; M<sub>3+4</sub> shorter than r-m; m-cu elongate and very oblique in position; male hypopygium with caudal margin of tergite having a broad U-shaped notch; inner dististyle with the apical beak very long and slender; ninth sternite on either side produced into a pale fleshy lobe.

Male.—Length, about 11 millimeters; wing, 12; antenna, about 4.

Rostrum and palpi black. Antennæ black, the apex of pedicel a trifle paler; flagellar segments with basal enlargements very slightly developed, the verticils scarcely one-half the length of the segments, on the outer segments becoming even shorter; terminal segment reduced to a small berrylike structure. Head gray, clearer light gray on front and anterior vertex, the latter very wide.

<sup>&</sup>lt;sup>4</sup> Philip. Journ. Sci. 46 (1931) 270.

<sup>&</sup>lt;sup>5</sup> Tome cit. 272.

<sup>&</sup>lt;sup>6</sup> Journ. Fed. Malay St. Mus. 14 (1928) pl. 1, fig. 20.

Pronotum and mesonotum entirely coal black, polished. Pleura black, the surface sparsely pruinose; dorsopleural mem-Halteres long, the stem obscure yellow, the brane dark brown. Legs with the coxæ blackened; trochanters yellow; knob dusky. remainder of legs black, the femoral bases rather narrowly obscure yellow. Wings (Plate 1, fig. 5) with a strong brownish yellow tinge; stigma oval, dark brown; obliterative areas before stigma and across base of cell 1st M<sub>2</sub>; veins light brown. Abundant macrotrichia in cells beyond cord, with the exception of 1st M<sub>2</sub>, in cells M<sub>3</sub> to 1st A becoming progressively fewer and more nearly restricted to vicinity of margin. Venation:  $R_{1+2}$  preserved; petiole of cell M1 shorter than m; M3+4 shorter than r-m; basal section of M<sub>4</sub> perpendicular; m-cu elongate and very oblique, somewhat as in the subgenus Schummelia, cell M<sub>4</sub> thus markedly widened at base.

Abdominal tergites black, the basal sternites more brownish; hypopygium black. Male hypopygium (Plate 2, fig. 26) relatively small, the tergite completely separated from the sternite, 9s: basistyle delimited by straight sutures, the cephalic portion fused with the sternite. Ninth tergite, 9t, with caudal margin produced into two flattened, dark-colored lobes, glabrous, their apices obliquely truncated; notch between lobes broadly U-shaped; dorsal surface of tergite with abundant setæ, these lacking only on the narrow median area and on the posterior border. dististyle, od, a small oval spatulate lobe, with numerous setæ. Inner dististyle, id, blackened, produced into a long slender black beak, with a shorter black lobe lying more basad, the two together roughly resembling an irregular pair of pincers. Ninth sternite. 9s, behind on either side produced into a pale fleshy lobe, provided with numerous long setæ. Eighth sternite unarmed.

Habitat.—Formosa.

Holotype, male, Kanshirei, altitude 1,500 feet, May 13, 1933 (S. Issiki).

Tipula (Trichotipula) haplotricha is a true member of the subgenus, the first to be reported from Japan or Formosa. The fly requires comparison with no other Japanese species of the genus having macrotrichia in the outer cells of the wing. From other species of the subgenus, it is readily told by the polished black mesonotum and the rich brownish yellow coloration of the wings. The degree of trichiation of the wings is much less than in T. (T.) polytrichia Alexander (western China).

TIPULA (VESTIPLEX) NESTOR sp. nov. Plate 1, fig. 6; Plate 2, fig. 27.

Belongs to the *himalayensis* group; mesonotal præscutum dark gray, with four broad dark brown stripes; antennal scape and pedicel light yellow, flagellum black; femora yellow, before midlength passing into brown, the tips conspicuously blackened, preceded by a clear yellow ring; wings yellowish subhyaline, with pale and darker brown areas; basal five abdominal segments chiefly yellow, with ill-defined markings, the outer segments uniformly blackened; male hypopygium with caudal margin of ninth tergite with a very broad V-shaped notch, the lateral lobes thus formed slender and pale; basistyle obtuse at tip.

Male.—Length, about 14 millimeters; wing, 18.5.

Frontal prolongation of head ocherous above, dark brown laterally beneath; nasus elongate, brownish black; palpi black. Antennæ of moderate length; scape and pedicel yellow, flagellum black throughout; verticils subequal to or a trifle longer than the segments. Head brownish yellow, with a narrow brown longitudinal stripe extending from the summit of anterior vertex to shortly before occipital band.

Mesonotal præscutum somewhat discolored, the ground color dark gray, with four broad dark brown stripes, the intermediate pair barely separated by a capillary gray vitta, their mesal edges narrowly blackish; lateral borders more ocherous; scutum dark gray, each lobe with two confluent dark brown stripes; scutellum and mediotergite dark gray, with a more or less distinct median dark vitta. Pleura with anepisternum and sternopleurite chiefly darkened and pruinose; posterior sclerites and pleurotergite much paler, more ocherous. Halteres with stem obscure brownish yellow, knobs dark brown with pale apices. Legs with the coxe and trochanters chiefly pale; femora yellow basally, before midlength passing into brown, the tips conspicuously blackened, preceded by a clearer yellow subterminal ring; tibiæ brownish black, the tips narrowly blackened; tarsi black. Wings (Plate 1, fig. 6) with the usual pattern of the group; postarcular brown area conspicuous and clearly delimited; cream-colored areas in outer ends of anal cells restricted in size but welldefined; whitish spot before stigma entirely surrounded by brown. Venation: R4 long and gently sinuous, cell R3 at margin considerably more extensive than cell R4; inner end of cell 1st M, pointed; m-cu close to fork of M<sub>3+4</sub>.

Abdomen with basal five tergites yellow, with very ill-defined dusky median and sublateral stripes, on basal three or four segments unusually narrow, on the fifth segment the laterals much heavier; sixth tergite black except for a restricted obscure yellow area on either side of median line; succeeding segments and hypopygium black; basal five sternites uniformly yellow, the outer four black. Male hypopygium (Plate 2, fig. 27) with the tergite separated from sternite except on cephalic portion; basistyle well delimited by a pale suture above, the apex obtuse, not or scarcely produced. Ninth tergite, 9t, relatively short, the caudal margin with a very broad V-shaped notch, the very slender lateral lobes paler than the remainder of sclerite, fringed with long pale setæ; on ventral surface of sclerite on either side and separated by pale membrane is a slender black chitinized point, not shown in figure. Mesal or inner face of basistyle, b, with a flattened ribbonlike blade, with five or six setæ near apex. Outer dististyle, od, a spatulate blade. Inner dististyle, id, narrowed at apex into a blackened beak. sternite with margin gently and convexly rounded, unarmed; pale medially at margin; a broken transverse row of pale spots or punctures near base of sclerite.

Habitat.—Formosa.

Holotype, male, Kanzangoe, Taitô-chô Kaimosu to Kanzananbu, August 19, 1932 (Esaki).

There are now several species in Formosa that appear to belong to the himalayensis group of Vestiplex, such including arisanensis Edwards, bicornuta Alexander, biserra Edwards, foliacea Alexander, terebrata Edwards, and probably quadrifulva Several of these are still known only from the female Edwards. The present fly differs notably from all other species in which the male sex is known in the structure of the hypopygium. Among the other species, it agrees most nearly with terebrata Edwards (Formosa, in May), differing especially in the details of coloration of the head, thorax, and abdomen, and in the finer points of wing pattern. Edwards's figure of the wing of terebrata 7 shows the costal and subcostal cells to be much darker than in the present species, the pale areas in anal field more extensive and diffuse, and with the basal section of vein M<sub>3</sub> longer than the basal section of  $M_{1+2}$ . The discovery of the male sex of terebrata will probably show points of difference in the hypopygium.

<sup>&#</sup>x27;Ann. & Mag. Nat. Hist. IX 8 (1921) pl. 10, fig. 16.

TIPULA (VESTIPLEX) PARVAPICULATA sp. nov. Plate 1, fig. 7; Plate 2, figs. 28, 29.

Belongs to the *himalayensis* group; mesonotal præscutum olive-gray, with four narrow grayish brown stripes that are slightly margined with darker brown; antennal flagellum weakly bicolorous; apices of knobs of halteres conspicuously whitish; femora yellowish brown, the tips blackened, preceded by a clearer yellow ring; wings light brown, variegated with darker brown and cream-colored areas as in the group; cell R<sub>3</sub> at margin a little more extensive than cell R<sub>4</sub>; basal abdominal tergites reddish yellow, trivittate with brownish black; outer four segments uniformly brownish black; male hypopygium with caudal margin of tergite broadly emarginate; basistyle obtuse at tip but produced into a small acute black spine; a long slender arm from mesal face of basistyle is bifid at tip into two acute spines.

Male.—Length, about 15 millimeters; wing, 18.5.

Frontal prolongation of head ocherous above, darker laterally beneath. Antennæ of moderate length only; basal three segments pale; succeeding segments weakly bicolorous, the basal enlargements black, the outer portions brown, only the outer segments becoming uniformly darkened. Head olive-gray, with a conspicuous brown line on posterior vertex, this sending a capillary vitta onto summit of vertical tubercle, the line being further produced behind to the occiput.

Mesonotal præscutum olive-gray, with four narrow grayish brown stripes that are slightly margined with dark brown, the ground color most distinct on cephalic ends of the intermediate stripes; scutal lobes similar, each with two clearly separated dark brown areas; posterior sclerites of mesonotum gray, with a conspicuous median brown line. Pleura chiefly olive-gray, variegated by darker areas, especially on ventral anepisternum, ventral sternopleurite and on posterior sclerites, the pleurotergite with a ridge of the ground color. Halteres dusky, the base of stem restrictedly pale: base of knob dark brown, the apex of same conspicuously pale. Legs with coxe olive-gray; trochanters yellow; femora chiefly light yellowish brown, the tips blackened, preceded by a clearer yellow ring; tibiæ dark brown, the tips narrowly blackened; tarsi black. Wings (Plate 1, fig. 7) light brown, variegated by darker brown and cream-colored areas, as in the group; postarcular darkening in cells R and M extensive and clearly defined; cream-colored area immediately before origin of Rs extensive; pale spot before stigma barely confluent with the pale color in cell R<sub>1</sub>; outer cream-colored area in cell M much restricted in area; pale areas in outer ends of anal cells very small and ill-defined; veins brown, paler in the flavous costal region. Venation: Cell  $R_3$  at margin a little more extensive than cell  $R_4$ .

Abdomen with the basal four tergites chiefly reddish yellow, trilineate with brownish black, the lateral borders beyond the base broadly grayish; tergite five more darkened apically; outer four segments uniformly brownish black. Male hypopygium (Plate 2, fig. 28) with the tergite, 9t, fused basally with the sternite; basistyle, b, cut off from sternite by broad and deep dorsal, and narrow, less distinct, ventral sutures, the narrow central portion being fused, without sutures. Ninth tergite, 9t, with the dorsal surface pale, with a more-blackened central band that is narrowly interrupted at the midline; caudal margin of tergite broadly emarginate, the lateral lobes wide but thin; a small median denticle; from ventral surface of tergite on either side a black flattened plate, its margin microscopically serrulate. Basistyle (Plate 2, fig. 29, b) with the broadly obtuse apex further produced into a tiny black apiculate point, the ventromesal portions further produced mesad into slender arms that are blackened and curved into weak spines at tips, not widely separated at the midline of body; a conspicuous arm of basistyle. b, is produced caudad as a slender rod, at apex divided into two acute spines, one subapical and smaller than the axial spine; lower margin of this sclerotized arm with a sparse fringe of long erect yellow setæ distributed the entire length of the structure. Dististyles, id, od, as shown. Ninth sternite with a median membranous U-shaped incision. Eighth sternite unarmed but with an interrupted transverse row of pale punctures on basal half.

Habitat.—Northern Formosa.

Holotype, male, Taiheizan, Taihoku-shû, October 24, 1932 (Keishô Satô).

Tipula (Vestiplex) parvapiculata is still another of the now numerous species of the himalayensis group in Formosa. All such species are most readily and safely classified by the details of structure of the male hypopygium. On such a character, the present fly is told by the small apiculate black point at apex of the basistyle. Compared with the Formosan species of the group that were described by Edwards, the fly agrees most nearly with T. (V.) biserra Edwards in the bicolorous antennal flagellum, differing most evidently in the pattern of the legs and wings

and in the venation, especially of the outer radial field, where vein  $R_3$  is not deflected cephalad at its outer end, thus narrowing cell  $R_2$ . It cannot be stated whether these now rather numerous species of the group are definitely seasonal in distribution, as is the case with most holarctic species of the genus. The present fly is on the wing in autumn, whereas all of Edwards's species (arisanensis, biserra, quadrifulva, and terebrata) are adult in April and May. It is questionable, further, whether quadrifulva belongs to the subgenus Acutipula or to Vestiplex; the wing pattern is much as in members of the himalayensis group of Vestiplex, but the brief description of the ninth tergite of the male hypopygium is very suggestive of the condition found in Acutipula.

#### TIPULA (ACUTIPULA) OBTUSILOBA sp. nov. Plate 2, fig. 30.

Belongs to the *munda* group; allied to *oncerodes*, differing chiefly in the structure of the male hypopygium, especially of the inner dististyle, the outer lobe of which is obtusely rounded and unarmed except for a small acute spine on the outer margin at near midlength.

Male.—Length, about 19 to 21 millimeters; wing, 24 to 26. Frontal prolongation of head obscure yellow, the elongate nasus brown; palpi dark brown. Antennæ short, not exceeding the head in length; scape and pedicel yellow; flagellum bicolorous, the bases of the segments weakly darkened, the apices yellow, the outer segments more uniformly darkened; verticils much longer than the segments. Head dark brown, probably pruinose in fresh specimens, discolored in types.

Mesonotum almost uniformly brown, without distinct markings; mediotergite darker, with conspicuous yellow setæ. Pleura more yellowish, paler than the notum. Halteres slender, obscure yellow, the knobs darker. Legs yellowish brown to brown, elongate. Wings grayish subhyaline, cells C and Sc, with the stigma more yellowish brown; veins slightly darker brown. Venation: Second section of  $M_{1+2}$  rather strongly arcuated; petiole of cell  $M_1$  a little longer than m.

Abdominal tergites rather light brown, the outer segments somewhat darker; sternites more brownish yellow. Male hypopygium with the median lobe of tergite as viewed from above (Plate 2, fig. 30, 9t) slender, with conspicuous black spinous points at tip and for a short distance basad. Outer dististyle flattened, entirely pale. Inner dististyle, *id*, with the apical beak pale, only the margin blackened, relatively stout; outer lobe

with apex obtusely rounded, unarmed except for a single acute spinous point on outer or posterior margin at near midlength of lobe.

Habitat.—Northern Formosa.

Holotype, male, Taiheizan, Taihoku-shû, Kamiyodani, July 25, 1932 (*Esaki*). Paratopotype, male.

Tipula (Acutipula) obtusiloba is most nearly allied to T. (A.) oncerodes Alexander and T. (A.) platycantha Alexander, of western China, differing in the structure of the hypopygium, more especially of the inner dististyle. The beaklike portion of the style is much stouter than in platycantha, while the armature of the outer lobe is quite different in all three species. The species of Acutipula from Japan proper, with the wings unmarked, including T. (A.) bipenicillata Alexander and T. (A.) tokionis Alexander, have the hypopygium of very different structure.

TIPULA (OREOMYZA) KOREANA sp. nov. Plate 1, fig. 8; Plate 2, fig. 31.

Belongs to the marmorata (fragilis) group; scape and pedicel yellow, flagellum black; femora yellow, the tips conspicuously brownish black; wings gray, variegated by dark brown and cream-colored areas as in the group; a dark cloud at outer end of cell  $R_2$  and adjoining parts of  $R_3$ ; cells Sc and  $Cu_1$  uniformly darkened; male hypopygium with the tergite produced into two divergent points; inner dististyle black, gradually narrowed into a long slender apical point; eighth sternite projecting, narrowed outwardly, the slender obtuse apex densely clothed with abundant short yellow setæ.

Male.—Length, about 13 millimeters; wing, 15.

Female.—Length, about 17 to 20 millimeters; wing, 15.5 to 18.

Frontal prolongation of head gray; nasus elongate; palpi dark brown. Antennæ with scape and pedicel yellow; flagellum black; flagellar segments (male) rather strongly incised for a member of this group, the longest verticils subequal to the segments. Head gray.

Pronotum gray. Mesonotum light gray, the præscutum with four bright brown stripes, the intermediate pair not attaining the suture behind and each split at anterior ends, the outer margin extended a slight distance cephalad beyond the internal border; scutal lobes variegated with brown. Pleura gray, the dorso-pleural membrane buffy brown. Halteres yellow, the knobs dark

brown. Legs with the coxe gray; trochanters yellow; femora yellow, the tips conspicuously brownish black; tibiæ obscure yellow, the tips brownish black; tarsi black, the proximal ends of basitarsi more brightened. Wings (Plate 1, fig. 8) with the ground color gray, variegated by dark brown and cream-colored areas; stigma and cells Sc and Cu<sub>1</sub> uniformly brown; prearcular region light yellow, cell C brownish yellow; restricted brown seams along anterior cord, at origin of Rs, outer end of cell R<sub>2</sub>, and adjoining central portion of cell R<sub>3</sub>; wing margin narrowly seamed with brown; paler brown clouds in cells M, Cu, and anals as in group; veins brown. Crossveins m and m-cu with complete series of macrotrichia. Venation: Sc<sub>2</sub> ending opposite midlength of the relatively long Rs; m-cu not far beyond inner end of cell 1st M<sub>2</sub>, M<sub>3+4</sub> being short to very short; m-cu on M<sub>4</sub> shortly beyond base; veins  $R_3$ , second section of  $M_{1+2}$ ,  $M_1$  and  $M_2$  all arcuated, as common in group.

Abdomen with basal tergite brownish gray; segments two and three, together with base of four, light yellow, the outer segments more uniformly brownish gray. In female, the subbasal tergites are more or less distinctly bordered laterally by darker. Male hypopygium (Plate 2, fig. 31) with the tergite, 9t, fused with sternite except for a distal suture; basistyle chiefly fused with sternite. Ninth tergite, 9t, with the caudal margin produced into two blackened, decurved, and slightly divergent points; apical margin on ventral surface slightly more tumid and set with small blackened points. Outer dististyle, od. flattened, the dorsal margin at base heavily blackened but not produced into a tooth as in several species of the group. Inner dististyle, id, almost uniformly blackened, narrowed at apex into a long slender black spine, with a small fleshy lobule on each side at base; face of style on posterior portion near base produced into a long acute black spine. Basistyle not produced but its inner or ventral margin heavily blackened and produced into a small black spine, shown in figure. Eighth sternite, 8s. long, produced into a shovellike lobe, narrowed outwardly, the tip fringed with abundant short yellow setæ; sclerite brown, with a conspicuous yellow median midline.

Habitat.—Korea.

Holotype, male, Kongo San, October 8, 1933 (*Machida*). Allotopotype, female, October 17, 1933. Paratopotypes, 3 females, October 8 to 18, 1933 (*Machida*).

I consider the present fly to be somewhat more nearly allied to *Tipula* (*Oreomyza*) kiushiuensis Alexander, of southern Japan, than to the various Siberian species (cupida Alexander, docilis Alexander, fidelis Alexander). However, it is very distinct from all in hypopygial characters, notably of the inner dististyle and eighth sternite.

## TIPULA (OREOMYZA) OBNATA sp. nov. Plate 1, fig. 9; Plate 2, fig. 32.

General coloration gray, with a continuous brown median vitta extending from vertex of head to base of abdomen; præscutal interspaces with numerous dark punctures; legs black; wings whitish, the costal region more yellowish; cell Sc before arculus darkened; several of the longitudinal veins narrowly but conspicuously seamed with black;  $R_{1+2}$  chiefly atrophied; basal abdominal tergites yellow, narrowly trivittate with brown; outer segments more uniformly brownish black; male hypopygium with the median region of tergite with a broad median notch; apex of eighth sternite with abundant setæ.

Male.—Length, about 9.5 millimeters; wing, 11.

Female.—Length, 12 to 13 millimeters; wing, 12 to 13.5.

Frontal prolongation of head light gray above, dark below and on sides; palpi black. Antennæ, if bent backward, extending to beyond the wing root; scape, pedicel, and basal segment of flagellum yellow; succeeding flagellar segments weakly bicolorous, the basal enlargements black, the remainder dark brown; verticils shorter than the segments. Head light gray, with a very delicate capillary dark median vitta.

Mesonotum gray, with a continuous median brown vitta extending from cephalic portion of præscutum to base of abdomen, scarcely or but slightly interrupted at the various sutures; præscutal stripes four, only insensibly darker gray than the ground; interspaces with conspicuous brown setigerous punctures; scutal lobes conspicuously variegated with dark brown. Pleura light gray, the dorsopleural region pale yellow. Halteres with stem pale, the knobs darkened. Legs with the coxæ yellow, sparsely pruinose; trochanters yellow; remainder of legs black, femora scarcely brightened basally; in allotype, the posterior femora show very vague indications of a subterminal obscure yellow ring. Wings (Plate 1, fig. 9) with the ground color whitish, the posterior prearcular region and cell Sc clear light yellow, cell C a trifle more brownish yellow; anterior prearcular region, especially in cell Sc, conspicuously dark brown; a re-

stricted dark brown pattern, including the stigma, cord, vein Cu, including cell Cu<sub>1</sub>, a slight postarcular darkening and narrow dark seams on veins  $R_{4+5}$ , outer half of M, all branches of M, and all of 2d A except the very narrow basal portion; a much paler brown clouding in outer radial cells; vein 1st A not seamed with brown; veins dark, more flavous in the yellow areas described. Venation:  $R_{1+2}$  persisting only as a short basal spur; cell  $M_1$  large; cell 1st  $M_2$  relatively small.

Abdomen with basal four or five segments yellow, the tergites narrowly trivittate with brown; midline of sternum similarly darkened; outer segments more uniformly brownish black. Male hypopygium (Plate 2, fig. 32) with the tergite, 9t, separate from the sternite, 9s; basistyle chiefly delimited from sternite. Ninth tergite, 9t, with a broad median notch, the dorsal face with a median incised line. Outer dististyle, od, pale, dilated outwardly, the apex obliquely truncated. Inner dististyle, id, with a row of about fifteen to eighteen slender setæ on outer margin but without a blackened basal spine, as in edwardsella. Eighth sternite, 8s, large and sheathing, the slope of its obtuse outer end with abundant setæ; in membrane between the eighth and ninth sternites, on midline of body, a further brush of long setæ. Ædeagus relatively short and stout.

Habitat.—Formosa.

Holotype, male, Hassenzan, Taichu-shû, Reimei, July 13, 1932 (*Esaki*). Allotopotype, female, Reimei-Piawaikei-Baibarasan, July 13, 1932 (*Esaki*). Paratype, female, Taiheizan, Taihoku-shû, Toganoo, July 21, 1932 (*Esaki*).

The nearest ally of the present fly seems undoubtedly to be Tipula (Oreomyza) edwardsella Alexander (flavicosta Edwards, preoccupied), likewise from the high mountains of Formosa, on the wing in May. This fly lacks the median dark vitta on the posterior sclerites of the mesonotum, as also the dark punctures on the præscutal interspaces. The details of the wing pattern, venation, halteres, coloration of abdomen, and structure of the male hypopygium, are likewise distinct. The larger Tipula pluriguttata Alexander similarly has the atrophied vein  $R_{1+2}$  and conspicuous setigerous punctures on the præscutal interspaces, but is entirely different in coloration of the body and wings; its male is still unknown to me.

# LIMONIINÆ LIMONIINI

LIMONIA (LIMONIA) MELAS sp nov. Plate 1, fig. 10; Plate 3, fig. 33.

Belongs to the *globithorax* group; general coloration of entire body dark brown or brownish black; antennæ black throughout, basal flagellar segments globular; halteres and legs black; wings very strongly suffused with blackish; male hypopygium with the tergite deeply notched medially, each lobe conspicuously produced; rostral spines at extreme base of outer face of dististyle, the apex of the latter gently emarginate and set with powerful setæ; a small black point some distance before apical spine of gonapophysis.

Male.—Length, about 4.5 millimeters; wing, 5.5.

Rostrum and palpi black. Antennæ black throughout; basal flagellar segments globular, the outer ones passing into short-oval; terminal segment slenderer but scarcely longer than the penultimate. Head brownish black; anterior vertex a little brightened, a trifle wider than the diameter of the scape.

Pronotum and mesonotum dull dark brown or brownish black; setæ on anterior interspaces long and conspicuous; scutellum a little paler. Mesonotum high and gibbous, as in the group. Pleura dark brown. Halteres black throughout. Legs with the coxæ dark brown; trochanters testaceous; remainder of legs black. Wings (Plate 1, fig. 10) very strongly suffused with blackish; cells C and Sc a trifle darker, prearcular cells a little paler; veins black. Venation:  $Sc_1$  ending beyond midlength of Rs,  $Sc_2$  at its tip; free tip of  $Sc_2$  pale, more than its own length before level of  $R_2$ , the intervening section of vein  $R_1$  with about five trichia; m-cu at fork of M.

Abdomen, including hypopygium, black. Male hypopygium (Plate 3, fig. 33) with the tergite, 9t, deeply notched medially, each lobe conspicuously produced. Dististyle, d, with the rostral spines at extreme base on outer margin, as in the group; style flattened, very gently widened outwardly, the apex very slightly emarginate and fringed with abundant strong powerful setæ; other more delicate setæ on outer and inner margins of style but none on disk. Gonapophyses, g, with mesal-apical lobe produced into a long curved black spine, with a further small blackened point as base of the narrowed portion. Entire surface of ædeagus, a, covered with abundant delicate setulæ.

Habitat.—Southern Formosa.

Holotype, male, Keinensan, altitude 5,400 feet, August 14, 1933 (*Issiki*).

The nearest allies of the present fly are Limonia (Limonia) globithorax (Osten Sacken) of northeastern North America, and its very close vicarious representative, L. (L.) globulithorax (Alexander), of northern Japan. The present species is readily told from these by differences in the structure of the male hypopygium, especially of the tergite, dististyles, and gonapophyses.

It may be doubted that the two pale spines placed at the extreme base of the outer face of the dististyle are really homologous with the rostral spines found elsewhere throughout the genus, and it seems advisable at this time to point out a few of the intermediate stages that have culminated in this peculiar Normally the spines are one, or more often two, in number and are placed on a lobe or produced area on the mesal face of the dististyle, commonly called the rostrum or rostral prolongation; when two dististyles are present, this rostral production is on the ventral style. The vast majority of all species in the genus (and including representatives of every one of the known subgenera of Limonia; namely, Alexandriaria. Dapanoptera, Dicranomyia, Discobola, Doaneomyia, Euglochina, Geranomyia, Goniodineura, Idioglochina, Laosa, Libnotes, Limonia, Neolimnobia, Peripheroptera, Pseudoglochina, Rhipidia, Thrypticomyia, Zalusa, and Zelandoglochina 8) have one or both of these spines present and placed on the rostral prolongation itself, usually at or beyond midlength, more rarely at or close to base of the prolongation. In a few cases (attaining an extreme in certain species of Dicranomyia and Rhipidia) the rostral spines may reach the number of a dozen or more, all placed on the prolongation. From this start we then find species where both spines are definitely removed from the prolongation onto the face of the style. Further progressive modifications move the spines caudad and thence cephalad around the periphery of the style, they being at the exact summit in L. (Discobola) margarita Alexander; beyond the summit and far distad on outer face of style in L. (Limonia) flavoterminalis Alexander; halfway between this point and the base on outer face in L. (Limonia) tabashii sp. nov. (Plate 3, fig. 34), and close to the extreme base in the present species (Plate 3, fig. 33), L. (Limonia) globithorax Osten Sacken, and several others of this general

<sup>&</sup>lt;sup>8</sup> Vide Alexander, Philip. Journ. Sci. 40 (1929) 241-244.

Thus in the Japanese fauna alone we have almost every possible position of the rostral spines on the periphery of the ventral dististyle. In other faunal regions, other curious deviations from the normal position may be found, as in Limonia (Limonia) firestonei Alexander and L. (L.) metatarsalba Alexander, of the Ethiopian Region, where the spines lie on the disk of the style. I have been somewhat detailed and specific in the above statement as I desire to show that even in as plastic a character as the position of these spines all subgeneric groups show this fundamental character and show close interrelationships. Certain students of the Tipulidæ still maintain Limonia as being distinct from Dicranomyia, Geranomyia, and other familiar groups in this complex, believing that the hypopygium of Limonia has a construction very different from that of the other mentioned groups. That this belief has no basis in fact becomes readily apparent when one studies a considerable range of types throughout the genus.

# LIMONIA (LIMONIA) TABASHII sp. nov. Plate 1, fig. 11; Plate 3, fig. 34.

Belongs to the *globithorax* group; antennæ black throughout; mesonotum only slightly gibbous, fulvous to orange, the pleura pale yellow; legs and halteres chiefly darkened; wings uniformly tinged with brown; stigma lacking; Sc relatively short, ending just beyond one-third the length of Rs; abdominal tergites dark brown, the basal sternites and hypopygium yellow; male hypopygium with the dististyle narrowed to the rostral portion, at apex with a blackened spine; rostral spines lying on outer face of style at about one-third the distance from base.

Male.—Length, about 4 to 4.2 millimeters; wing, 4.8 to 5.

Rostrum and palpi reduced in size, dark. Antennæ black throughout; flagellar segments subglobular, the outer ones slightly more elongate; terminal segment strongly constricted and narrowed beyond midlength; longest verticils unilaterally arranged and exceeding the segments in length. Head light fulvous.

Mesonotum only slightly gibbous, light fulvous to orange, the scutellum a little more obscure. Pleura pale yellow. Halteres brown, the stem obscure yellow. Legs with the coxæ and trochanters pale yellow; femora obscure yellow, the tips weakly darkened; tibiæ dark brown; tarsi black. Wings (Plate 1, fig. 11) uniformly tinged with brown; stigma lacking; veins darker brown. Venation: Sc relatively short, Sc<sub>1</sub> ending at just beyond one-third the length of Rs, Sc<sub>2</sub> at its tip; free tip of Sc<sub>2</sub>

lying opposite or just before level of  $R_2$ ; m-cu at fork of M, subequal to distal section of  $Cu_1$ .

Abdominal tergites dark brown; basal sternites yellow, the outer ones somewhat darker; hypopygium yellow. Male hypopygium (Plate 3, fig. 34) with the tergite, 9t, large, narrowed outwardly, the caudal margin with a U-shaped notch, the obtuse lateral lobes with long conspicuous setæ. Basistyle, b, relatively slender, the ventromesal lobe at outer end. Dististyle, d, fleshy, much smaller than the basistyle, oval, the rostral portion more narrowed and terminating in an acute blackened spine; rostral spines two, migrated to the outer face of style at about one-third the distance from base. Gonapophyses, g, with mesal-apical lobe long and slender, nearly straight. Ædeagus, a, broad, the central portion profoundly bifid.

Habitat.—Korea.

Holotype, male, Suigen, September 16, 1930 (*Tabashi*); No. 28. Paratopotype, male.

Limonia (Limonia) tabashii is named in honor of the collector of this interesting material. The species needs no comparison with other members of the group, being readily told by the fulvous mesonotum and structure of the male hypopygium, especially of the dististyle and the position thereon of the rostral spines.

## LIMONIA (LIBNOTES) BASISTRIGATA sp. nov. Plate 1, fig. 12.

Coloration of entire thorax and abdomen pale yellow; antennal flagellum yellow, the narrowed outer half of the terminal segment black; knobs of halteres brownish black; legs yellow, the tips of femora and tibiæ broadly black; vestiture of femora consisting of very small spinous setæ; wings yellow, sparsely variegated with dark brown; a conspicuous black streak between wing base and crossvein h, occupying cells C and Sc; setæ of costal fringe short; ovipositor with cerci bifid at tips.

Male.—Length, about 13 to 15 millimeters; wing, 19 to 21. Female.—Length, about 15 millimeters; wing, 19.

Rostrum dark brown; palpi black. Antennæ with scape brown; pedicel and antennæ light yellow, the apical half of last segment suddenly blackened; flagellar segments subglobular to short-oval, with verticils that are shorter (on basal segments) to a little longer than the segments; terminal segment longer and suddenly narrowed on distal end. Head gray, the posterior vertex chiefly suffused with rich brown; anterior vertex narrow, about one-third the diameter of scape.

Pronotum, mesonotum, and pleura entirely pale yellow, unmarked. Halteres yellow, the knobs brownish black. Legs with the coxe and trochanters light yellow; femora yellow, the tips broadly and conspicuously blackened; tibiæ yellow, the tips a little more narrowly blackened; basitarsus and second segment brownish yellow, the tips narrowly blackened; outer three tarsal segments more uniformly blackened; vestiture of legs consisting of abundant but very small spinous setæ, on tarsi somewhat longer and more appressed. Wings (Plate 1, fig. 12) strongly tinged with pale yellow, the costal border to apex clearer bright yellow; a conspicuous black streak extends from wing base to h in cells C and Sc; restricted dark brown seams at origin of Rs, along cord, Sc<sub>2</sub>, free tip of Sc<sub>2</sub>, and R<sub>2</sub>; outer end of cell 1st M2; a continuous dark seam on outer half of basal section of Cu<sub>1</sub> and the entire distal section of the same vein; vein R<sub>4+5</sub> more narrowly seamed with brown, its base and apex clear; outer half of vein 2d A seamed with brown; extreme axillary region darkened; veins yellow, brown in the infuscated areas. Setæ of costal fringe abundant but very short; trichia of veins small and delicate. Venation: Free tip of Sc2 and R2 in approximate transverse alignment; R3 and R4 parallel on outer ends and very strongly decurved; m about twice the basal section of M<sub>3</sub>; m-cu a little more than its own length beyond the fork of M; anal veins convergent basally.

Abdomen, including hypopygium, entirely light yellow. Male hypopygium of the usual structure of the subgenus; lobe of ventral dististyle with four or five long powerful setæ; spines of rostral prolongation elongate, nearly as long as the prolongation itself, arising close together from a short common tubercle, one spine slightly lower than the other. Ovipositor with cerci bifid at tips.

Habitat.—Korea.

Holotype, male, Kongo San, October 16, 1933 (*Machida*). Allotopotype, female, October 17, 1933. Paratopotype, male, with the allotype.

The nearest allied species is *Limonia* (*Libnotes*) nohirai (Alexander), of Korea and northern Japan, which differs conspicuously in the dark brownish gray coloration of the mesonotum and pleura, the differently patterned wings, such as the lack of the black basal streak, the differently patterned abdomen, and other characters. The two species are evidently allied, agreeing in the

general pattern of the wings and legs, the reduced vestiture of the costal vein and the legs, and the bifid tips of the cerci.

LIMONIA (LIBNOTES) GRISEOLA sp. nov. Plate 1, fig. 13.

General coloration dark brownish gray; antennæ black throughout; mesonotal præscutum with indications of three brown stripes; knobs of halteres weakly darkened; femora yellow, the tips narrowly blackened; wings tinged with yellow, sparsely patterned with brown along cord and outer end of cell 1st  $M_2$ ; wing tip narrowly darkened; basal section of  $R_{4+5}$  long, fully one-half Rs; free tip of  $Sc_2$  and  $R_2$  in transverse alignment; m-cu at midlength of cell 1st  $M_2$ ; abdomen brownish black; cerci with simple tips.

Female.—Length, about 8 millimeters; wing, 8.5.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval, with verticils that are subequal in length to the segments; terminal segment fully twice as long as the penultimate, strongly narrowed outwardly. Head dark gray, the linear anterior vertex more silvery gray.

Mesonotal præscutum dark brownish gray, with three very indistinct dark brown stripes that are sparsely dusted with pollen; posterior sclerites of notum gray, the scutal lobes darker in cen-Pleura dark brown, dusted with gray. Halteres pale yellow, the knobs weakly infuscated. Legs with the coxe darkened, their apices paler; trochanters yellow; femora yellow, the tips rather narrowly but conspicuously blackened; tibiæ brownish yellow, the tips narrowly blackened; basitarsi obscure yellow; remainder of legs broken. Wings (Plate 1, fig. 13) tinged with yellow, the prearcular and costal regions clearer yellow; wing tip in outer radial field weakly darkened; stigma narrow, appearing as a dark seam on R<sub>2</sub>; narrow and very ill-defined dark clouds at origin of Rs, along cord, and on outer end of cell 1st M<sub>2</sub>, chiefly indicated by a darkening of the veins at these points. Macrotrichia on longitudinal veins beyond cord and on distal half of M, Rs except base, and tips of both anal veins. tion: Sc<sub>1</sub> ending about opposite midlength of the basal section of  $R_{4+5}$ ,  $Sc_2$  at its tip; Rs relatively long, about twice the long basal section of  $R_{4+5}$ ; free tip of  $Sc_2$  and  $R_2$  in transverse alignment; cell 1st M<sub>2</sub> with outer elements subequal and transverse; veins beyond the cell elongate; m-cu at near midlength of cell 1st  $M_2$ ; anal veins generally parallel at bases.

Abdomen brownish black throughout. Cerci relatively small, simple, blackened at bases.

Habitat.—Formosa.

Holotype, female, Hassensan, Taichu-shû, Reimei-Piawaikei-Baibarasan, July 13, 1932 (*Esaki*).

Limonia (Libnotes) griseola is somewhat similar to L. (L.) hassensana Alexander, likewise from Hassensan, but is really a very different fly. The unusually long basal section of  $R_{4+5}$  and very gently concave or sinuous vein 2d A furnish important characters, additional to those of coloration of the body, legs, and wings.

#### LIMONIA (DICRANOMYIA) KONGOSANA sp. nov. Plate 1, fig. 14; Plate 3, fig. 35.

Belongs to the *morio* group; size unusually large (wing, 9 millimeters or over); mesonotal præscutum polished black, the surface very sparsely pruinose; knobs of halteres brownish black; wings with the stigma dark brown, conspicuous, preceded and followed by cream-colored areas;  $Sc_1$  longer than Rs; abdominal tergites black; male hypopygium with the caudal margin of tergite broadly emarginate, the lateral lobes obtuse; dorsal dististyle terminating in an acute spine; rostral spine of ventral dististyle fasciculate, from an enlarged base.

Male.—Length, about 8.5 millimeters; wing, 9.5.

Female.—Length, about 8.5 to 9 millimeters; wing, 9 to 9.5.

Rostrum black, sparsely pruinose; palpi black. Antennæ black throughout; flagellar segments oval. Head light gray; anterior vertex relatively wide.

Mesonotum black, the surface of præscutum very sparsely pruinose so as to dim the polished sclerites that are usual in the group; median region of scutum, base of scutellum, and mediotergite more heavily pruinose. Pleura black, heavily gray pruinose. Halteres elongate, yellow, the knobs brownish black. Legs with the fore coxæ black, their apices yellow; remaining coxæ light yellow; trochanters yellow; femora obscure yellow, the tips rather narrowly brownish black; tibiæ and tarsi brownish black. Wings (Plate 1, fig. 14) with a rather strong brown tinge, the oval stigma dark brown; prearcular region and costal border, including areas before and beyond stigma, more creamcolored; veins brown. Venation: Sc<sub>1</sub> ending opposite origin of Rs, Sc<sub>2</sub> far from its tip, Sc<sub>1</sub> alone about one-third longer than Rs; free tip of Sc<sub>2</sub> more than its own length basad of R<sub>2</sub>, the section of R<sub>1</sub> between with abundant macrotrichia; m-cu at or close to fork of M; vein 2d A long, gently sinuous.

Abdominal tergites black; sternites obscure brownish yellow. Male hypopygium (Plate 3, fig. 35) with the caudal margin of

the ninth tergite, 9t, broadly emarginate, the lateral lobes obtuse, with numerous long setæ. Basistyle, b, relatively large, its ventromesal lobe conspicuous. Dorsal dististyle, dd, strongly bent at near midlength, the apex an acute spine. Ventral dististyle, vd, relatively large and fleshy, the rostral prolongation stout, bearing a single powerful fasciculate spine from an enlarged base. Gonapophyses, g, with the mesal-apical lobe short. Ædeagus very large, at base with very abundant and dense erect setæ, on the dilated outer portions these much shorter and more scattered.

Habitat.—Korea.

Holotype, male, Kongo San, October 17, 1933 (*Machida*). Allotopotype, female, October 16, 1933. Paratopotypes, 3 females, October 8 to 17, 1933 (*Machida*).

The only near ally of the present fly in the Asiatic fauna is Limonia (Dicranomyia) paramorio (Alexander), which is much smaller, with the stigma pale and inconspicuous, and with a very different structure of the male hypopygium, notably of the dististyles and ædeagus. By Lackschewitz's key to the western Palæarctic species of the morio group  $^9$  the present fly runs to couplet 4, including L. (D.) caledonica (Edwards) and L. (D.) stylifera (Lackschewitz), small species with very distinct male hypopygia. The present fly is by far the largest member of the group so far discovered.

#### ELLIPTERA ZIPANGUENSIS TAIWANICOLA subsp. nov.

Male.—Length, about 5 millimeters; wing, 7.3.

Characters as in typical zipanguensis Alexander, of Hokkaido, differing as follows: Mesonotum and pleura black, the surface sparsely pruinose. Legs black. Wings more strongly tinged with blackish. Venation:  $R_{2+3}$  short, poorly indicated, shorter than r-m. Abdomen, including sternites and hypopygium, black.

Habitat.—Southern Formosa.

Holotype, male, Keinensan, altitude 5,400 feet, August 17, 1933 (Issiki).

The discovery of the occurrence of a true *Elliptera* south of the Tropic of Cancer is of great interest, all other known species being recorded only from north of 30° north latitude. I am

<sup>&</sup>lt;sup>9</sup> Ann. Naturhist. Mus. Wien 42 (1928) 218-219.

indebted to Mr. K. Takeuchi for a translation of the paper by S. Iwata,<sup>10</sup> written entirely in Japanese, where the following record is given:

7. Elliptera, sp. Distributed throughout the river but more especially in the lower portion. I found larvae, pupae and cast pupal skins.

The species in question, if a true *Elliptera*, may be *Elliptera* jacoti Alexander (Shantung, China; Korea) or E. zipanguensis Alexander (Hokkaido) or an undescribed species.

# DICRANOPTYCHA NIGROTIBIALIS sp. nov. Plate 1, fig. 15.

General coloration of body dark brown or brownish black, the thorax dusted with yellow pollen; legs with the femora black, the bases obscure yellow, before the tips with indications of a more reddish brown ring; tibiæ and tarsi black; wing strongly tinged with brown, the prearcular and costal regions light yellow; veins dark brown; cell 1st  $M_2$  unusually small, about two-thirds as long as Rs;  $R_{1+2}$  about twice  $R_2$ ; abdomen dark brown.

Female.—Length, about 9.5 millimeters; wing, 10.5.

Rostrum and palpi dark brown. Antennæ light brown; scape yellow pollinose; outer six or seven flagellar segments passing into black; flagellar segments subcylindrical, the longest verticils fully twice the segments. Head yellowish gray; anterior vertex broad, nearly three times the diameter of scape.

Mesonotum dark brown or brownish black, dusted with yellow pollen; præscutum with indications of two narrow intermediate brown stripes; pseudosutural foveæ black, conspicuous. Pleura dark, heavily dusted with pollen, the dorsal pleurites considerably darker than the sternopleurite. Halteres pale, the knobs vaguely darkened. Legs with the coxæ brown, sparsely pollinose; trochanters obscure yellow; femora black, the bases obscure yellow, including about the basal fourth of the segment; indications of a vague, more reddish brown ring before tips of femora; tibiæ and tarsi black; legs with a long erect pubescence. Wings (Plate 1, fig. 15) strongly tinged with brown, the prearcular region and cells C and Sc light yellow; veins dark brown, luteous in the yellow areas. Venation: Cell 1st  $M_2$  unusually small, only about two-thirds the length of Rs;  $R_{1+2}$  about twice  $R_2$ ; m-cu shortly before midlength of cell 1st  $M_2$ .

<sup>&</sup>lt;sup>10</sup> Aquatic insects of the Kamogawa River, Kyoto. V. Diptera, Trans. Kansai Ent. Soc. 1 (1930) 54.

Abdomen dark brown, including the dorsal shield of ovipositor; cerci horn-colored, relatively short; basal abdominal sternites obscure brownish yellow, the subterminal segments brownish black.

Habitat.—Southern Formosa.

Holotype, female, Fudieda, altitude 4,700 feet, August 13, 1933 (*Issiki*).

Dicranoptycha nigrotibialis is readily told from all other species in eastern Asia by the coloration of the legs. It is not closely allied to any of the three other species in Formosa.

#### PEDICIINI

DICRANOTA (RHAPHIDOLABIS) PLANA sp. nov. Plate 1, fig. 16; Plate 3, fig. 36.

General coloration light gray, the præscutum with three grayish brown stripes; antennæ black throughout; legs chiefly brownish black, the tarsi somewhat paler; wings with a pale grayish suffusion, the stigma scarcely indicated; R<sub>2+3+4</sub> longer than r-m; abdomen dark brown; male hypopygium with the median area of tergite nearly transverse; setæ on mesal face of basistyle unusually strong and powerful, especially toward the proximal end; interbase a large, broadly flattened plate.

Male.—Length, about 4.5 millimeters; wing, 5.3.

Rostrum and palpi black, the former pruinose. Antennæ black throughout, short; flagellar segments oval, the outer segments broken. Head light gray.

Pronotum gray. Mesonotal præscutum clear blue-gray, with three grayish brown stripes, the median stripe not quite reaching the suture; posterior sclerites of notum dark plumbeous gray. Pleura gray, the dorsopleural membrane brown. Halteres pale, the knobs dusky. Legs with the coxe gray; trochanters testaceous; femora dark brown, the tips narrowly blackened; tibiæ brown; tarsi elongate, rather pale brown, the outer segments blackened; posterior basitarsi subequal in length to tibiæ. Wings (Plate 1, fig. 16) with a pale grayish suffusion, the prearcular region pale yellow; stigma scarcely indicated, a trifle paler than the ground color, very diffuse; veins brown, more yellowish in the prearcular field. Venation: Sc1 ending some distance beyond fork of  $R_{2+3+4}$ ;  $Sc_2$  far before origin of Rs; Rs rather strongly arcuated;  $R_2$  erect, longer than  $R_{1+2}$ ; cell  $R_3$  petiolate,  $R_{2+3+4}$ being longer than r-m; m-cu more than one-half its length beyond the fork of M.

Abdomen dark brown. Male hypopygium (Plate 3, fig. 36) with the median region of the tergite, 9t, only slightly protuber-

ant, being virtually transverse, provided with numerous coarse setæ; lateral tergal spines, 9t, broad-based, twisted at midlength. Basistyle with setæ of mesal face very strong and powerful, becoming larger toward base of sclerite. Outer dististyle, od, with the usual spines; inner dististyle, id, with apex flattened into a spatula. Interbase, i, large, broadly flattened, shaped about as in the figure, the extreme margins of the two outer lobes very insensibly serrulate.

Habitat.—Southern Formosa.

Holotype, male, Keinensan, altitude 5,400 feet, August 14, 1933 (*Issiki*).

Dicranota (Rhaphidolabis) plana is conspicuously different from the only other described Formosan species of the subgenus, D. (R.) atripes Alexander, the hypopygium being very distinct in all details. The group of powerful setæ on mesal face of basistyle is suggestive of the condition in D. (R.) consors Alexander, of Honshiu and Kiushiu, but the other structures and body coloration are again very different. The degree of convexity of the median region of the tergite is the slightest known from any of the eastern Asiatic species of Rhaphidolabis, excluding the flavibasis group, where the caudal border of the tergite is deeply emarginate.

## HEXATOMINI

LIMNOPHILA (PRIONOLABIS) HARUKONIS sp. nov. Plate 1, fig. 17; Plate 3, fig. 37. Size small (wing, male, about 8 millimeters); general coloration polished coal-black; antennæ 13-segmented; knobs of halteres weakly darkened; femora blackened, the bases restrictedly yellow, more extensively so on the posterior legs where about the basal third is included; wings with a strong brown suffusion, only the prearcular region more yellowish; cord and outer end of cell 1st M<sub>2</sub> weakly seamed with dusky; R<sub>2</sub> and R<sub>1+2</sub> subobsolete; male hypopygium with the caudal margin of tergite evenly emarginate between two blackened tubercles; outer dististyle with a single lateral denticle.

Male.—Length, about 6.5 millimeters; wing, 8.

Rostrum and palpi black. Antennæ black throughout, 13-segmented; basal flagellar segments short-oval, crowded, the outer segments more elongate; terminal segment about one-half longer than the penultimate. Head polished black, the front and anterior vertex little if any pruinose.

Prothorax and mesothorax entirely polished black, without pruinosity. Halteres obscure yellow, the knobs weakly dark-

ened. Legs with the coxæ and trochanters polished black; femora black, the bases narrowly pale, narrowest on forelegs, a little more extensive on the hind femora where about the basal third is brightened; tibiæ dark brown, the tips narrowly blackened; tarsi dark brown. Wings (Plate 1, fig. 17) with a strong brown suffusion, only the prearcular region yellower; stigma very poorly defined; origin of Rs, cord, and outer end of cell 1st  $M_2$  very vaguely seamed with dusky; veins brownish black, more luteous in the prearcular field. Venation:  $R_2$  and  $R_{1+2}$  both so faint as to be scarcely visible, apparently subequal, as figured; petiole of cell  $M_1$  longer than the cell; m-cu at near midlength of cell 1st  $M_2$ .

Abdomen, including hypopygium, polished black. Male hypopygium (Plate 3, fig. 37) with the caudal margin of tergite, 9t, produced into a small blackened tubercle on either side of the median line, the space between gently and evenly emarginate. Outer dististyle, od, with a single lateral tooth, which is strongly developed into a curved black spine. Inner dististyle, id, before the obtuse blackened apical point bearing a slender tubercle that is tridentate at apex.

Habitat.—Formosa.

Holotype, male, Hassensan, Reimei, July 13, 1932 (Esaki).

This distinct species is named in honor of Miss Haruko Esaki, eldest daughter of Professor Teiso and Mrs. Lotte Esaki. It is very different from the other species having 13-segmented antennæ (imanishii Alexander, luteibasalis Alexander) being more generally similar to Limnophila (Prionolabis) oritropha Alexander, a larger, yellow-winged species from the high mountains of Formosa. The diagnostic features listed above are sufficient to separate the fly from all allied forms. The males of L. (P.) luteibasalis and L. (P.) odai Alexander have the median region of the tergite narrowly and weakly trilobed, quite different from the condition found in other Japanese and Formosan species of Prionolabis.

#### HEXATOMA (ERIOCERA) MASAKII sp. nov. Plate 1, fig. 18.

Belongs to the *chirothecata* group; general coloration of mesonotal præscutum and scutum black, the pleura and posterior sclerites of mesonotum more brownish; head and abdominal tergites uniformly orange; antennæ (male) about twice as long as the wing, the basal four segments light yellow, the incisures of the basal two flagellar segments narrowly darkened; outer flagellar segments more uniformly darkened; flagellar segments

without spinous armature, only with conspicuous setæ that become longer on the outer segments; femora yellow, the tips narrowly but conspicuously blackened; wings tinged with brown, the costal border broadly darker brown, this color continued to the wing tip; abdominal tergites orange, the lateral borders and centers of the sternites variegated with black.

Male.—Length, about 11 millimeters; wing, 9.5; antenna, about 19.

Rostrum short, orange; palpi dark brown. Antennæ (male) elongate, approximately twice the length of the wing; scape, pedicel, and basal two flagellar segments yellow, the incisures narrowly but conspicuously dark brown; terminal segments more uniformly infuscated; flagellar segments with delicate scattered setæ only, without spines as is usual in the genus; setæ of outer segments much longer and more conspicuous than on the basal segments. Head orange; vertical tubercle very weakly notched at summit.

Pronotum and mesonotal præscutum and scutum blackened, the surface rather polished; scutellum and mediotergite more brown-Pleura brown, the dorsal sclerites darker. Halteres black. Legs with the coxe yellowish brown; trochanters obscure yellow; femora yellow, the tips narrowly but conspicuously blackened; tibiæ obscure yellow, the tips narrowly infuscated; basitarsi obscure yellow, the outer tarsal segments passing into black. Wings (Plate 1, fig. 18) with a brown tinge, the entire costal border to the wing tip conspicuously darker brown, this including cells C and Sc and the stigma; origin of Rs, cord and outer end of cell 1st M<sub>2</sub> more weakly suffused with brown; cell Cu paler than remainder of disk; veins brown. Macrotrichia of veins abundant, including complete series on all longitudinal radial veins beyond cord and more-scattered series on the outer sections of M<sub>1+2</sub> and M<sub>3</sub>. Venation: Rs elongate, considerably exceeding R;  $R_{2+3}$  longer than  $R_2$ ;  $R_{1+2}$  longer than  $R_{2+3}$  but shorter than R<sub>2+8+4</sub>; m-cu more than one-half its length beyond the fork of M.

Abdominal tergites orange, the lateral borders of segments narrowly blackened; sternites orange, the lateral borders darkened; segments two to seven each with a conspicuous median blotch; hypopygium more brownish orange.

Habitat.—Korea.

Holotype, male, Suigen, August 4, 1930 (Tabashi); No. 23.

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The present fly is named in honor of Prof. Jujiro Masaki, who has added considerably to our knowledge of the Korean Tipulidæ. The species is very different from all other regional species with elongate antennæ in the male sex in the nonspinous flagellar segments, in conjunction with the rather striking coloration of the body and wings. I would believe it to be most nearly allied to Hexatoma (Eriocera) kolthoffi Alexander (eastern China: Kiangsu), of which only the female sex is known to this date. This latter fly differs in the yellow head, with entire vertical tubercle, the uniformly black legs, and the brownish black abdomen. It will be of interest to learn whether this species also has elongate antennæ, with reduced vestiture, as in the present fly.

#### ERIOPTERINI

## CLADURA (CLADURA) MACHIDELLA sp. nov. Plate 1, fig. 19.

General coloration of entire body black, sparsely dusted with gray; fore femora black, only the extreme bases obscure yellow; posterior femora with outer third blackened; tarsi black; wings yellow, patterned with brown on the crossveins and distal two-thirds of Cu; supernumerary or adventitious crossveins in cells  $R_3$  and  $R_4$  in approximate alignment with  $R_2$ .

Female.—Length, about 9 millimeters; wing, 10.

Rostrum and palpi black. Antennæ black, only the extreme base of the first flagellar segment pale; flagellar segments cylindrical; terminal segment less than one-half as long as the penultimate. Head dark gray.

Mesonotum and pleura black, sparsely pruinose. pale yellow, the knobs very weakly darkened. Legs with the fore coxæ darkened, pale apically; remaining coxæ and all trochanters yellow; fore femora black, only the extreme bases obscure yellow; middle legs broken; posterior femora obscure yellow, the outer third blackened; tibiæ brown, the tips darker brown; basitarsi dark brown, the tips and all outer tarsal segments black. Wings (Plate 1, fig. 19) strongly tinged with yellow, the basal and costal portions brighter yellow; a conspicuous dark brown pattern, appearing as seams to the crossveins and certain of the longitudinal veins, as follows: Origin of Rs; cord; outer end of cell 1st  $M_2$ ;  $Sc_2$ ; fork of  $R_{2+3+4}$ ;  $R_2$ ; the supernumerary crossveins in cells R<sub>3</sub> and R<sub>4</sub>; smaller dark spots at tips of veins  $R_{1+2}$ ,  $R_3$ , and  $R_4$ ; a broad, conspicuous, dark seam beginning at about one-third the length of vein Cu, extending uninterrupted to margin, slightly invading cell M and filling the entire space between veins  $Cu_1$  and  $Cu_2$ ; veins yellow, dark in the clouded areas. Venation: Sc relatively long,  $Sc_1$  ending about opposite m,  $Sc_2$  opposite the fork of  $R_{2+3+4}$ ; in the unique type, two supernumerary or adventitious crossveins, one each in cells  $R_3$  and  $R_4$ , lying in almost perfect alignment with  $R_2$  (in direct alignment in one wing; the element in cell  $R_3$  just distad of the others, as figured, on the opposite side); r-m strongly arcuated and weakly spurred; petiole of cell  $M_1$  slightly longer than m; m-cu shortly beyond the fork of M.

Abdomen black, the pleural membrane conspicuously more buffy yellow. Genital segment brownish yellow; valves of ovipositor reddish horn-color.

Habitat.—Japan (Honshiu).

Holotype, female, Mount Hiei, Kyoto, October 30, 1933 (Machida).

This strikingly distinct fly is named in honor of my friend Prof. Jiro Machida, to whom I am greatly indebted for kindly coöperation in studying the Tipulidæ of the Japanese Empire. It is the eighth Japanese and Formosan species of the genus to be described and is readily told from all other members of *Cladura* in the black coloration of the body and the chiefly black legs. It seems probable that the crossveins in the radial field of the wing may prove to be adventitious rather than supernumerary, a comparable condition being found in the genotype, *Cladura flavoferruginea* Osten Sacken, of eastern North America. This was studied by Alexander and Leonard <sup>11</sup> and the venation as regards crossveins was found to be remarkably plastic.

#### TRENTEPOHLIA (TRENTEPOHLIA) FUSCOBASALIS sp. nov. Plate 1, fig. 20.

Belongs to the *trentepohlii* group; characters as in *trente-pohlii*, but basal segments of abdomen uniformly dark brown, almost as intense in color as the outer blackened segments.

Male.—Length, about 5.5 millimeters; wing, 5.4.

Female.—Length, about 7 millimeters; wing, 5.3.

Rostrum and labial palpi yellow; maxillary palpi darker. Antennæ black; flagellar segments long-oval to subcylindrical. Head dark gray; anterior vertex reduced to a linear strip or virtually lacking.

Mesonotal præscutum rather bright brown, more yellowish laterally; scutal lobes, scutellum, and mediotergite darker brown. Pleura brown, the posterior sclerites more yellowish. Halteres

<sup>&</sup>lt;sup>11</sup> Journ. N. Y. Ent. Soc. 20 (1912) 36-39, pl. 4.

chiefly pale, the knobs slightly dusky. Legs with the fore coxe pale brown, the remaining coxe and all trochanters yellow; remainder of legs yellow, the terminal tarsal segments blackened. Wings (Plate 1, fig. 20) yellowish white, the costal region light yellow; wing tip, including radial and medial fields, more uniformly infuscated; narrow brown seams along cord and vein Cu; vein  $R_{4+5} + M_{1+2}$  narrowly seamed with dark brown, interrupting the otherwise pale band beyond cord; center of cell  $R_3$  scarcely brightened; veins brown, luteous in the costal field. Venation: All veins in region of stigma so faint as to be virtually obliterated, the outer end of R,  $R_{1+2}$ , and  $R_2$  being obsolete or nearly so; outer four-fifths of  $R_{2+8+4}$  very pale and semiatrophied but evident; cell 2d A relatively wide.

Basal abdominal segments dark brown, the outer segments a little more blackened.

Habitat.—Formosa.

Holotype, male, Tansui, October 29, 1933 (Issiki).

Allotype, female, Jitsugetsutan (Lake Candidius or Dragon Lake), November 4, 1932 (Machida).

This species, or perhaps race, has undoubtedly been confused in Formosa with Trentepohlia (Trentepohlia) trentepohlii (Wiedemann), which has the basal segments of the abdomen yellow or reddish yellow. The dark color of the basal abdominal segments of the present fly is not quite as intense as in the otherwise distinct T. (T.) pictipennis Bezzi (Luzon to Papua). The insect fauna of Lake Candidius has been well considered by Takahashi. T2

#### Genus GONOMYIA Meigen

#### Subgenus PROTOGONOMYIA subgen. nov.

Characters much as in Progonomyia Alexander, differing especially in the short fleshy valves of the ovipositor. In all other subgeneric groups of Gonomyia, the valves are elongate, with acutely pointed cerci. Wings with cell  $R_3$  deep, almost as in the genus Gnophomyia, the branches inclosing the cell subparallel or but slightly divergent on basal half; cell 1st  $M_2$  open by atrophy of basal section of  $M_3$ ; m-cu close to fork of M.

Type of subgenus.—Gonomyia confluenta Alexander (Oriental Region: Formosa).

Other included species: Gonomyia (Protogonomyia) clitellata sp. nov.; G. (P.) nigripes Brunetti (includes nigra Brunetti,

<sup>&</sup>lt;sup>12</sup> Trans. Nat. Hist. Soc. Formosa 20 No. 108 (1930) 145-156.

incompleta Brunetti, and probably gracilis Brunetti); G. (P.) perturbata Alexander; and G. (P.) scutellum-album Alexander.

Gonomyia tenebrosa Edwards has the valves of the ovipositor elongate and sclerotized and should be retained in *Progonomyia*. The subgeneric position of *G. brunnescens* Edwards is still uncertain as the female has not been described.

GONOMYIA (PROTOGONOMYIA) CLITELLATA sp. nov. Plate 1, fig. 21; Plate 3, fig. 38.

Size small (wing, male, 4.5 millimeters); præscutum, scutum, and mediotergite black, the scutellum, pleura, and pleurotergite abruptly yellow; head black, dusted with gray; knobs of halteres orange-yellow; wings with a faint brown tinge;  $Sc_1$  extending to about opposite midlength of Rs;  $R_{2+3+4}$  about twice the basal section of  $R_5$ ; abdominal tergites black, the hypopygium and sternites yellow; male hypopygium with the spine of the inner dististyle long and acute; ædeagus slender, terminating in a small, acute, recurved spine.

Male.—Length, about 4 millimeters; wing, 4.5.

Rostrum and palpi black. Antennæ of moderate length, black throughout; flagellar segments oval. Head black, dusted with gray, more heavily so on anterior portions.

Pronotum brownish yellow, a little darker in front; anterior lateral pretergites clear light yellow. Mesonotal præscutum and scutum intense black, the surface somewhat opaque by a sparse bloom; scutellum light yellow, the parascutella darkened; mediotergite black. Pleura and pleurotergite yellow, somewhat more reddish yellow on ventral anepisternum and ventral sternopleu-Halteres pale, the knobs orange-yellow. Legs with the fore and middle coxæ reddish yellow, the posterior coxæ clearer yellow; trochanters obscure yellow; remainder of legs broken. Wings (Plate 1, fig. 21) with a faint brown tinge; veins pale Macrotrichia on all veins beyond cord; on Rs except basal fifth, distal third of M, and about the outer half of 2d A: vein 1st A without trichia. Venation: Sc1 extending to about opposite midlength of Rs, Sc2 not clearly apparent and omitted from figure; Rs very long;  $R_{2+3+4}$  about twice the basal section of R<sub>5</sub>; cell M<sub>1</sub> longer than its petiole; m-cu close to fork of M.

Abdominal tergites black, the eighth and ninth tergites, including hypopygium, more yellowish; sternites yellow. Male hypopygium (Plate 3, fig. 38) with the basistyle, b, produced beyond the level of the insertion of the dististyles as a scooplike expanded blade, the apex obtuse; ventromesal lobe with retrorse setæ. Outer dististyle, od, yellow, gradually narrowed to the

apical spinous point, the lower or concave edge at midlength with abundant delicate setulæ. Inner dististyle, id, bifid at midlength, the shorter arm conspicuously setiferous, the longer arm decussate, appearing as a slender straight spine. Ædeagus, a, apparently slender, not highly compressed as in scutellum-album, the apex terminating in an acute recurved spine.

Habitat.—Northern Formosa.

Holotype, male, Rimosan, May 2, 1933 (Issiki).

Gonomyia (Protogonomyia) clitellata is very different from all other described members of the group. The peculiar thoracic pattern, together with the structure of the hypopygium, will readily serve to distinguish the species from the allied regional forms.

# GONOMYIA (GONOMYIA) SEKIANA sp. nov. Plate 1, fig. 22; Plate 3, fig. 39.

Belongs to the *cognatella* group; antennæ black, the basal segments brighter; pleura with a broad whitish longitudinal stripe; knobs of halteres light yellow; legs black; abdominal tergites bicolorous, dark brown, the caudal borders conspicuously pale yellow; male hypopygium with three dististyles, the outer terminating in a curved black spine and bearing a lateral tooth at near two-thirds the length; phallosome large and conspicuous, more or less hood-shaped.

Male.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi black. Antennæ black, the basal segments more obscure orange; antenna relatively long and slender, if bent backward extending about to wing root; flagellar segments long-oval, with an abundant short dense pubescence and long, unilaterally arranged verticils, one to each segment. Head with center of vertex darkened, the remainder obscure orange.

Pronotum pale yellow above, darkened laterally and beneath. Anterior lateral pretergites pale yellow. Mesonotal præscutum and scutum black, dusted with gray, the humeral and narrow lateral regions obscure yellow; median region of scutum obscure yellow; scutellum darkened basally, the broad posterior border yellow; mediotergite dark, with a narrow pale V-shaped transverse area at near midlength. Pleura with a broad whitish longitudinal stripe extending from behind the fore coxæ, crossing the dorsal sternopleurite, ventral pteropleurite, onto the meral region; dorsal anepisternum and ventral sternopleurite dark brown; remaining posterior sclerites of pleura more reddish brown. Halteres dusky, the knobs light yellow. Legs with the coxæ testaceous yellow; trochanters brownish yellow; femora

brownish black; tibiæ and tarsi black. Wings (Plate 1, fig. 22) with a pale brown tinge; prearcular region and cells C, Sc, and Cu, light yellow; stigma and vague seams along cord very pale brown; veins brown, yellow in the luteous areas. Macrotrichia relatively abundant on  $R_4$ ,  $R_5$ , all outer branches of M and Cu, outer ends of both anal veins, almost the whole length of  $R_{2+3+4}$  and  $R_5$ , and on outer ends of M and basal section of Cu<sub>1</sub>. Venation:  $Sc_1$  ending opposite origin of  $R_5$ ,  $Sc_2$  close to its tip; m-cu shortly before fork of M.

Abdominal tergites dark brown, the caudal borders of the segments conspicuously pale; hypopygium yellow; sternites more uniformly yellow. Male hypopygium (Plate 3, fig. 39) with the outer angle of basistyle, b, produced into a long pale rod that is provided along its margin near base with about eight long powerful spinous setw. Three dististyles, the outer, od, long and slender, terminating in a curved blackened point, at near two-thirds the length bearing a small acute spinous point; intermediate style, md, even longer, twisted on its own axis at base and again at proximal end of the long terminal black spine; inner style, id, shortest, its lower margin fringed with strong setw; at near four-fifths the length with a long powerful spinous seta, at apex with other shorter but still powerful setw. Phallosome, p, a very large, pale, more or less hood-shaped structure, shaped about as in figure.

Habitat.—Southern Formosa.

Holotype, male, Sekisan, altitude 6,000 feet, August 15, 1933 (*Issiki*).

The present fly is the first member of the cognatella group to be discovered in the Japanese Empire. It differs from the other regional species in eastern Asia, with the exception of aperta Brunetti, by the conspicuous yellow knobs of the halteres. From the latter species, of which the male hypopygium has not been adequately described, the present fly differs in the details of coloration of the thorax, the black legs, and, if Bagchi's figure of the venation is correct, in the venation, as the less strongly arcuated Rs, very strongly arcuated  $R_{2+3+4}$ , and oblique  $R_3$ . The male hypopygium is much larger and more complex in structure than in Gonomyia (Gonomyia) subcognatella Alexander, of western China.

ERIOPTERA (ILISIA) LULIANA sp. nov. Plate 1, fig. 23; Plate 3, fig. 40.

Allied to incongruens; mesonotum and pleura light gray, with three velvety black longitudinal stripes, one on lateral borders of præscutum and scutum, the other two more ventral, on pleura; femora yellow, the fore femora with two brown annuli, inclosing a narrow yellow subterminal ring; middle and posterior femora with a narrow brown subterminal ring; wings whitish subhyaline, with major occiliform areas bordered by brown but without brown dots elsewhere in the cells; cell 1st M<sub>2</sub> small; male hypopygium with the tergite deeply split medially; gonapophyses slender, the margins smooth.

Male.—Length, about 5 millimeters; wing, 5.5.

Rostrum and palpi black. Antennæ with basal segment black, succeeding segments pale brown, the outer four or five segments again blackened. Head brownish gray.

Mesonotal præscutum light gray, with indications of two intermediate and two nearly lateral brown stripes that are present on posterior half of sclerite only; lateral borders of præscutum and scutum broadly and conspicuously intense velvety black; pseudosutural foveæ and tuberculate pits black; posterior sclerites of notum light gray, the central portions of scutal lobes and posterior border of scutellum more darkened. Pleura gray. traversed by two longitudinal velvety black stripes, the more dorsal extending from the fore coxe across the ventral anepisternum and pteropleurite to pleurotergite; ventral stripe occupying the ventral sternopleurite and upper meral region; besides these two major stripes, the gray pruinosity is further lined with minor dark stripes on the more ventral gray vitta and on the ventral part of meron; dorsopleural membrane brown. Halteres yellow, the knobs very weakly darkened. Legs with the coxæ black, the posterior pair more pruinose; trochanters brownish black, more darkened beneath; fore femora yellow, with a broad dark brown ring at midlength, together with a paler brown ring at apex, its more basal portion darker, the two rings inclosing a narrow yellow subterminal annulus; middle and hind femora yellow, with a narrow brown subterminal ring; fore tibiæ yellow, a little infuscated near base; remainder of tibiæ and tarsi yellow, the outer tarsal segments black. Wings (Plate 1, fig. 23) whitish subhyaline; cells C and base of Sc uniformly infumed with pale brown; a conspicuous ocelliform pattern, beyond the cord with the central portions light brown, narrowly bordered by darker brown; basad of cord, the centers of the areas are of the ground color, their position and size indicated only by the dark borders; the largest of these areas lie at origin of Rs, anterior cord, and tip of Sc; stigmal area at end of

 $R_{1+2}$ ; an oblique crossband before wing tip, extending from outer end of cell  $R_2$  into extreme outer angle of cell  $M_4$ ; wing margin in outer ends of cells  $R_5$  to  $M_3$  darkened; other pale circles at outer ends of cells  $M_4$ , Cu, and 2d A, and at tip of vein 1st A; no dark dots on wing excepting one or two along vein Cu; veins yellow, darker in the infuscated areas, as along the cord, outer end of cell 1st  $M_2$  and outer end of vein 2d A. Venation: Cell 1st  $M_2$  unusually small, the second section of vein  $M_{1+2}$  being less than two-fifths of the outer section; m-cu more than one-half its length before fork of M.

Abdomen chiefly dark brown, the lateral borders of tergites more reddish brown; hypopygium light yellow. Male hypopygium (Plate 3, fig. 40) with the ninth tergite, 9t, entirely pale, with a deep median split, the lateral lobes thus formed broadly truncate. Outer dististyle, od, relatively slender, gently arcuated. Inner dististyle, id, entirely pale, with a long retrorse seta at apex. Gonapophyses appearing as slender smooth black horns, p, their tips gently incurved, on mesal face near base produced into a weak denticle.

Habitat.—Central Formosa.

Holotype, male, Hassensan, Taichû-shû, Reimei, July 12, 1932 (Esaki).

This beautiful Ilisia is named in honor of Miss Luli Esaki, youngest daughter of Professor and Mrs. Teiso Esaki. The only near ally in eastern Asia is Erioptera (Ilisia) incongruens Alexander (Honshiu), which differs in the brown coloration of the mesothorax, the thickly dotted interspaces of the wings, the large cell 1st  $M_2$ , the differently patterned legs, and the structure of the male hypopygium, especially the stout, approximated apophyses with the surface microscopically roughened, and the group of about a dozen long slender spines grouped on either side of the median line at base of the phallosome.

MOLOPHILUS EPHIPPIGER sp. nov. Plate 1, fig. 24; Plate 3, fig. 41.

Belongs to the *gracilis* group and subgroup; mesonotum black, contrasting abruptly with the reddish yellow pleura and pleurotergite; male hypopygium with the dorsal lobe of basistyle low, nonspinous; outer dististyle a simple sinuous rod, with abundant serrulations on the distal two-thirds; inner dististyle black, the apex split into two slightly divergent black spines.

Male.—Length, about 3.5 millimeters; wing, 4.5.

Female.—Length, about 4 millimeters; wing, 4.5.

Rostrum pale brown; palpi black. Antennæ short; scape light yellow, pedicel light brown, flagellum dark brown; flagellar segments oval. Front and anterior part of vertex light yellow, the remainder of vertex and the occiput dark plumbeous gray.

Pronotum and anterior lateral pretergites yellow. Mesonotal præscutum and scutum entirely polished black, the remaining sclerites of notum black, but slightly more opaque by a sparse pruinosity; lateral portions of mediotergite brightened. Pleura, including the dorsopleural membrane and pleurotergite, pale reddish yellow, contrasting abruptly with the notum. Halteres yellow, the knobs and outer portions of stems a little darkened, with pale setæ. Legs with the coxæ and trochanters yellow, femora brown, paler basally, darkened toward tips, with dark setæ; tibiæ brown, darker toward tips; tarsi black. Wings (Plate 1, fig. 24) with a faint brown tinge, the prearcular and costal regions light yellow; veins pale brownish yellow, the macrotrichia darker brown. Venation: R<sub>2</sub> in transverse alignment with r-m; petiole of cell M<sub>3</sub> nearly three times m-cu; vein 2d A ending opposite posterior end of m-cu.

Abdominal tergites dark brown medially, the intermediate segments broadly yellow laterally; sternites yellow, somewhat darker in female; hypopygium brownish yellow. Male hypopygium (Plate 3, fig. 41) with the dorsal lobe, db, of basistyle low, nonspinous, its apex subacute but entirely pale and with setæ to apex; mesal lobe with dense setulæ; ventral lobe, vb, longest, at apex with conspicuous retrorse setæ and with a row of erect setæ along margin. Outer dististyle, od, a simple, sinuous, ribbonlike rod, yellow on basal third, the remainder blackened; outer margin and surface on blackened portions with microscopic serrulations, on inner edge more limited to distal third. Inner dististyle, id, a shorter blackened rod, the apex split into two slightly divergent, acute, black spines that are slightly unequal in length and diameter. Ædeagus long and slender.

Habitat.—Central Formosa.

Holotype, male, Rantaisan, altitude 7,000 feet, May 16, 1933 (*Issiki*). Allotopotype, female, in copula with male.

Molophilus ephippiger is very different from all other regional species in the black mesonotum, contrasting abruptly with the pale pleura, and in the structure of the male hypopygium, notably the bifid inner dististyle.

# ILLUSTRATIONS

[a, Ædeagus; b, basistyle; d, dististyle; dd, dorsal dististyle; db, dorsal lobe of basistyle; g, gonapophysis; i, interbase; id, inner dististyle; md, intermediate dististyle; od, outer dististyle; p, phallosome; s, sternites; t, tergites; vb, ventral lobe of basistyle.]

#### PLATE 1

- FIG. 1. Trichocera mirabilis sp. nov., venation.
  - 2. Dictenidia inæquipectinata sp. nov., venation.
  - 3. Dolichopeza (Dolichopeza) issikiella sp. nov., venation.
  - 4. Dolichopeza (Mitopeza) taiwanicola sp. nov., venation.
  - 5. Tipula (Trichotipula) haplotricha sp. nov., venation.
  - 6. Tipula (Vestiplex) nestor sp. nov., venation.
  - 7. Tipula (Vestiplex) parvapiculata sp. nov., venation.
  - 8. Tipula (Oreomyza) koreana sp. nov., venation.
  - 9. Tipula (Oreomyza) obnata sp. nov., venation.
  - 10. Limonia (Limonia) melas sp. nov., venation.
  - 11. Limonia (Limonia) tabashii sp. nov., venation.
  - 12. Limonia (Libnotes) basistrigata sp. nov., venation.
  - 13. Limonia (Libnotes) griseola sp. nov., venation.
  - 14. Limonia (Dicranomyia) kongosana sp. nov., venation.
  - 15. Dicranoptycha nigrotibialis sp. nov., venation.
  - 16. Dicranota (Rhaphidolabis) plana sp. nov., venation.
  - 17. Limnophila (Prionolabis) harukonis sp. nov., venation.
  - 18. Hexatoma (Eriocera) masakii sp. nov., venation.
  - 19. Cladura (Cladura) machidella sp. nov., venation.
  - 20. Trentepollia (Trentepollia) fuscobasalis sp. nov., venation.
  - 21. Gonomyia (Protogonomyia) clitellata sp. nov., venation.
  - 22. Gonomyia (Gonomyia) sekiana sp. nov., venation.
  - 23. Erioptera (Ilisia) luliana sp. nov., venation.
  - 24. Molophilus ephippiger sp. nov., venation.

#### PLATE 2

- Fig. 25. Trichocera mirabilis sp. nov., male hypopygium.
  - Tipula (Trichotipula) haplotricha sp. nov., male hypopygium, details.
  - 27. Tipula (Vestiplex) nestor sp. nov., male hypopygium, details.
  - 28. Tipula (Vestiplex) parvapiculata sp. nov., male hypopygium, details.
  - Tipula (Vestiplex) parvapiculata sp. nov., male hypopygium, details.
  - 30. Tipula (Acutipula) obtusiloba sp. nov., male hypopygium, details.
  - 31. Tipula (Oreomyza) koreana sp. nov., male hypopygium, details.
  - 32. Tipula (Oreomyza) obnata sp. nov., male hypopygium, details.

## PLATE 3

- Fig. 33. Limonia (Limonia) melas sp. nov., male hypopygium.
  - 34. Limonia (Limonia) tabashii sp. nov., male hypopygium.
  - 35. Limonia (Dicranomyia) kongosana sp. nov., male hypopygium.
  - 36. Dicranota (Rhaphidolabis) plana sp. nov., male hypopygium.
  - 37. Limnophila (Prionolabis) harukonis sp. nov., male hypopygium.

  - 38. Gonomyia (Protogonomyia) clitellata sp. nov., male hypopygium. 39. Gonomyia (Gonomyia) sekiana sp. nov., male hypopygium.

  - 40. Erioptera (Ilisia) luliana sp. nov., male hypopygium.
  - 41. Molophilus ephippiger sp. nov., male hypopygium.

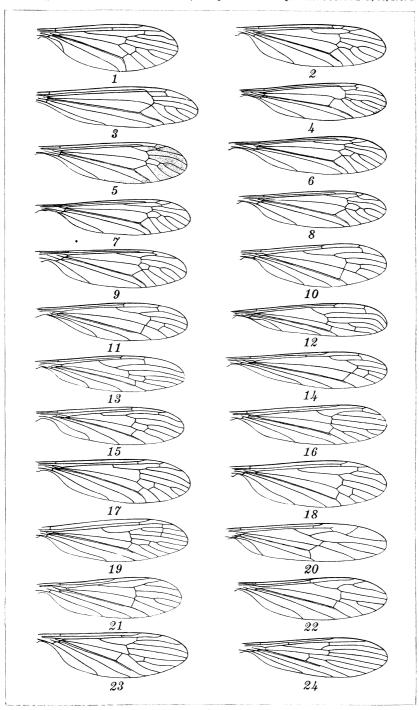


PLATE 1.



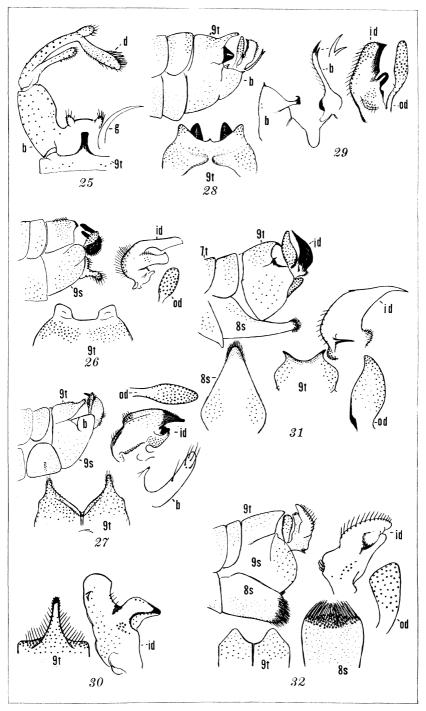


PLATE 2.



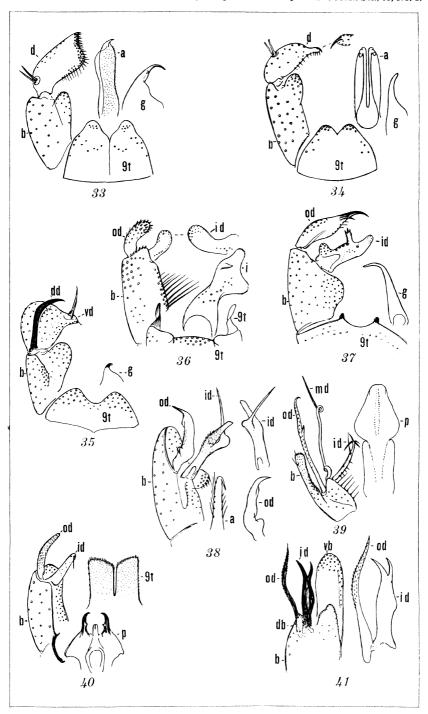


PLATE 3.

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# FOOD HABITS OF SIX COMMON LIZARDS FOUND IN LOS BAÑOS, LAGUNA, PHILIPPINE ISLANDS <sup>1</sup>

# By DEOGRACIAS V. VILLADOLID

Of the Fish and Game Administration, Bureau of Science, Manila

This report is based upon the examination of the contents of one hundred twenty-six well-filled stomachs of six species of lizards. These lizards were collected by students enrolled in zoölogy during the school year 1927–1928. The relative abundance of the food constituents was ascertained by the frequency of their occurrence in each of the stomachs examined.

The results of this study are embodied in two tables. Table 1 gives the actual composition of the stomach contents examined. Table 2 gives the relative abundance of the food constituents found.

# FOOD OF HEMIDACTYLUS FRENATUS DUMÉRIL AND BIBRON

The contents of forty-five stomachs consisted mostly of insect material; five stomachs contained spiders (arachnids) in addition to insects, while one lizard apparently swallowed also crustacean food and a bean besides insects.

Insect food.—The bulk of the stomach contents of twenty-two of the forty-five lizards examined consisted of Orthoptera, mostly roaches (Blattidæ), green crickets (Oecanthidæ), and tree crickets (Gryllacridæ). Small beetles (Coleoptera), the second most important food item of this lizard, were found in thirteen stomachs. Other orders of insects represented in the food of H. frenatus, in the order of their frequency, are Diptera (mostly flies), Homoptera (mostly leaf hoppers), Isoptera (mostly winged termites), Hymenoptera (mostly ants), and Odonata (dragon flies).

Animal food other than insects.—Arachnids (spiders) were found in six stomachs only. The order Crustacea was repre-

<sup>&</sup>lt;sup>1</sup> The data were secured by the writer during his incumbency as assistant professor of zoölogy, College of Agriculture, University of the Philippines.

sented by a species of fresh-water prawn (*Palæmon lanceifrons* Dana) found in a single stomach. It is most likely that the prawn, as well as a bean in the stomach of the same lizard, was picked up from a food cabinet, as this lizard is a frequent visitor to human habitations.

# FOOD OF GEKKO GECKO (LINNÆUS)

Seventeen stomachs of this lizard contained insects. One also contained a scorpion (Arachnida) besides insects, and another contained a centipede (Chilopoda) in addition to insects.

Insect food.—Orthoptera (mostly Locustidæ, Blattidæ) and Coleoptera (mostly Curculionidæ and Cerambycidæ) formed the bulk of the food of the geckos.

Animal food other than insects.—Very little noninsect food was found in the stomachs of the geckos. One scorpion (Arachnida) was found in a single stomach, while another stomach yielded three centipedes (Chilopoda).

# FOOD OF DRACO SPILOPTERUS (WIEGMANN)

Twenty stomachs of this lizard contained insects. These belonged to only two orders; namely, Hymenoptera and Coleoptera; ants form the bulk of the food. It seems then that this flying lizard has a marked preference for ants. Fire ants of the genus *Odontomachus* (Formicidæ), called "hantic" locally, were common in the stomachs of the flying lizards. Beetles of the family Curculionidæ were found in three stomachs.

## FOOD OF MABUYA MULTIFASCIATA KUHL

Insect food.—Fifteen stomachs examined contained insects. This lizard showed a marked preference for Orthoptera, mostly grasshoppers (Locustidæ) and crickets (Gryllidæ). Ten of the fifteen stomachs contained nothing but grasshoppers and crickets. Other insects found were beetles (Coleoptera), moths (Lepidoptera), and ants, bees, and other Hymenoptera.

Animal food other than insects.—Spiders were found in three stomachs examined. A fresh-water snail (Melania sp.) was found in a single stomach.

Vegetable constituent.—A piece of leaf was found in a single stomach. This was possibly taken accidentally.

## FOOD OF CALOTES MARMORATUS (GRAY)

The bulk of the food of this lizard consisted of beetles of the families Cicindelidæ and Passalidæ, and Orthoptera, mostly

grasshoppers and crickets. Other insect foods in the order of their frequency were Hymenoptera (ants and bees), Homoptera (mostly leaf-hoppers), and Diptera (flies and mosquitoes).

Millipedes (Diplopoda) were found in only two stomachs. Vegetable material in the form of leaves and leaf sheaths were found in four stomachs. A tiny bit of decaying twig was found in one stomach.

## FOOD OF TROPIDOPHORUS GRAYI GÜNTHER

Ten stomachs of this lizard contained nothing but insects belonging to the following orders, enumerated in the order of their importance: Orthoptera (mostly roaches, Blattidæ), Coleoptera (beetles), and Odonata (dragon flies).

# SUMMARY AND REMARKS

- 1. Although the species of lizards examined are rather common in Los Baños and vicinity, the number of stomachs dissected for each kind is not sufficiently large to enable us to draw definite conclusions. Although a large number of species were present in the collection, only those which had well-filled stomachs were used. Also specimens in excellent condition for museum purposes were not sacrificed for dissection.
- 2. It is apparent that the six species of lizards examined are all insectivorous. In the 126 stomachs dissected, the bulk of the food consisted of insects. Very few contained food other than insects, the noninsect food constituting only a very minor portion of the stomach contents.
- 3. It is likewise apparent that these lizards feed more on noxious insects than on beneficial ones.
- 4. Orthoptera, Coleoptera, Diptera, Lepidoptera, and Homoptera formed the bulk of the insect food of the house lizard. This is to be expected in view of the fact that these insects are the ones usually found attracted by the light during which time this lizard is feeding actively. Diptera that are not attracted by light must have been taken during daytime. At any rate flies are usually found in houses during daytime. The probable reason why winged termites were not represented in a larger percentage in the stomachs of the lizards, although this insect is easily attracted to the light, is its periodic occurrence.
- 5. Beetles of the families Curculionidæ and Cerambycidæ, and orthopterous insects of the family Blattidæ, formed the bulk of the food of the geckos. This was to be expected in view of

the habit of the geckos of frequenting holes in trees and the underside of bark, which are also the favorite haunts of beetles and roaches. It is because of this habit also that the geckos pick up centipedes and scorpions.

- 6. The flying lizards, *Draco spilopterus*, showed a marked food preference for ants. Even the fierce, biting fire ants were found in a relatively large proportion in the stomachs of this lizard. Each of the twenty stomachs dissected contained a few beetles.
- 7. The "chameleon," Calotes marmoratus, showed a rather marked preference for Coleoptera and Orthoptera.
- 8. The shrub lizard, Mabuya multifasciata, showed preference for Orthoptera, notably grasshoppers and crickets. This is probably due to the fact that these insects are generally found among grasses and shrubbery, which are the favorite feeding grounds of this lizard. The presence of a fresh-water snail in one of the stomachs of this lizard might be taken as an indication that it visits water once in a while. This gives also a possible explanation to a superstition among the Filipinos that this lizard, locally known as "bankalang," goes to the water to drink after biting, and if it reaches the water ahead of the victim, its bite becomes poisonous and fatal.
- 9. The food of the spiny lizard, *Tropidophorus grayi*, consisted of insects such as locusts, grasshoppers, leaf hoppers, and dragon flies, which frequent shrubbery and small trees along the creek. This lizard is generally confined to this type of habitat.

Table 1.—Showing the actual composition of the stomach contents of six species of lizards.

House lizard, Hemidactylus frenatus Duméril and Bibron:

#### Insecta-

Orthoptera; 39 grasshoppers and locusts; 3 cockroaches.

Coleoptera; 25 beetles.

Diptera; 10 flies; 7 mosquitoes.

Lepidoptera; 13 moths.

Homoptera; 17 leafhoppers.

Isoptera; 8 winged termites.

Hymenoptera; 18 ants. Odonata; 1 dragon fly.

Insect remains; significant amount.

Arachnida; 7 spiders.

Crustacea; 5 small fresh-water prawns.

Vegetable material; 1 bean seed.

Inorganic material; a few minute pieces of sand.

Table 1.—Showing the actual composition of the stomach contents of six species of lizards—Continued.

Flying lizard, Draco spilopterus Wiegmann:

Insecta-

Hymenoptera; 400 ants (Formicidæ); 100 "hantic" fire ants; genus Odontomachus.

Coleoptera; 6 beetles (Curculionidæ).

Gecko, Gekko gecko Linnæus:

Insecta-

Coleoptera; 30 beetles (Curculionidæ); 5 beetles (Cerambycidæ).

Orthoptera; 9 roaches (Blattidæ); 7 locusts and grasshoppers. Unidentified insect remains; significant.

Arachnida; 1 scorpion.

Chilopoda; 1 centipede. Vegetable material; 2 small grass leaves and 1 rice hull.

Shrub lizard, Mabuya multifasciata Kuhl:

Insecta-

Orthoptera; 13 locusts; 8 crickets.

Coleoptera; 2 beetles.

Lepidoptera; 4 pupæ of moths or butterflies.

Isoptera; 10 winged termites.

Hymenoptera: 1 ant.

Insect remains; significant quantity.

Arachnida; 3 spiders.

Mollusca; 1 fresh-water snail.

Vegetable matter; 3 minute pieces of straw.

Chameleon, Calotes marmoratus Gray:

Insecta-

Coleoptera; 30 beetles (Curculionidæ); 1 beetle (Cicindelidæ); 2 beetles (Passalidæ).

Orthoptera; 21 locusts and grasshoppers.

Hymenoptera; 50 ants (Formicidæ); 1 bee.

Diptera; 1 fly; 2 mosquitoes.

Insect remains; significant quantity.

Diplopoda; 2 millipedes.

Vegetable material; 3 small leaves and 2 leaf sheaths.

Spiny lizard, Tropidophorus grayi Günther:

Insecta-

Orthoptera; 10 locusts and grasshoppers; 2 cockroaches.

Hymenoptera; 18 ants. Coleoptera; 4 beetles.

Odonata; 3 dragon flies.

Insect remains; significant quantity.

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Table 2.—Showing the relative abundance of the food constituents.

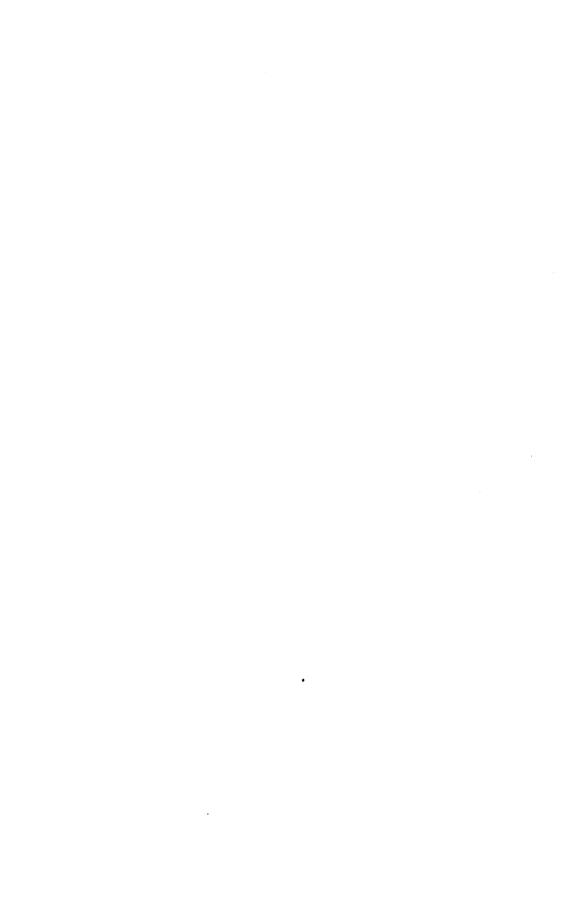
HEMIDACTYLUS FRENATUS; 45 STOMACHS.

Food item.	Stomachs in which found.	Percentage of occurrence
Insecta (insects)	45	100.00
Orthoptera	22	48.88
Coleoptera	13	28.88
Diptera	9	20.00
Lepidoptera	7	15.55
Homoptera	6	13.33
Isoptera	3	6.66
Hymenoptera	3	6.66
Odonata	1	2.22
Arachnida (spiders)	6	13.33
Crustacea (prawn)	1	2.22
Vegetable matter	1	2.22
GEKKO GECKO; 17 STOMACHS.	1	T
Insecta (insects)	ł.	100.00
Coleoptera	_	52.94
Orthoptera	1 .	41.20
Arachnida (scorpion)		5.89
Chilopoda (centipede)	1	5.89
Vegetable matter	2	11.78
DRACO SPILOPTERUS; 20 STOMACHS.		
Insecta (insects)	20	100.00
Hymenoptera (ants)	20	100.00
Coleoptera (beetles)	3	15.00
CALOTES MARMORATUS; 19 STOMACHS	3.	
Insecta (insects)	19	100.00
Coleoptera	1	63.16
Orthoptera	1	52,63
	1 .	21.05
Hymenoptera	1	5.03
Hymenoptera Homoptera	1	
	1 -	5.03
Homoptera	1 -	5.03 10.50

Table 2.—Showing the relative abundance of the food constituents—Ctd.

Mabuya multifasciata; 15 stomachs.

Food item.	Stomachs in which found.	Percentage of occurrence
Insecta (insects)	15	100.00
Orthoptera	10	66.66
Coleoptera	1	6.66
Lepidoptera	1	6.66
Isoptera	1	6.66
Hymenoptera	1	6.66
Arachnida (spiders)	8	20.00
Mollusca (fresh-water snail)	1	6.66
Vegetable matter	2	12.32
TROPIDOPHORUS GRAYI; 10 STOMACHS	5.	
Insecta (insects)	10	100.00
Orthoptera	4	40.00
Hymenoptera	8	30.00
	2	20.00
Coleoptera		



# FOOD AND FEEDING HABITS OF THE BARRED GROUND DOVE

By CANUTO G. MANUEL

Of the Fish and Game Administration, Bureau of Science, Manila

#### ONE PLATE

# INTRODUCTION

The abundance of the barred ground dove, Geopelia striata (Linnæus) (Plate 1), in and near rice paddies makes the study of its economic importance significant in a country like the Philippines.

The bird has several vernacular names descriptive of either its appearance or its habits. Around Manila it is known as bato batong katigbi, bato batong lupa, and bato batong kurokotok. These are all Tagalog names. The first refers to its color pattern which resembles the various shades of the seeds of a certain graminaceous plant called katigbi, Coix lachrymajobi Linn. The second denotes its ground habit, while the third is based on its cooing note. Wherever the barred ground dove occurs, its presence is known through the description that its name presents and its cooing note which sounds like "Kurr-rok kotók kok kok," soft and repeatedly uttered. Baker, (1) citing Davison, states that the note "sounds like 'kok-akurr-kurr' soft, but repeated several times."

Detailed systematic descriptions are given, among others, by Salvadori, (9) McGregor, (8) Baker, (1) and Hachisuka. (5)

# DISTRIBUTION

The species has a wide distribution. According to Baker, (1) it "is found in the extreme south of Tenasserim, whence it ranges south throughout the Malay Peninsula and Archipelago, as far east as the Philippines and in Siam, but is apparently rare in the latter place and was never met with by Count Guildenstolpe in 1911–12." Hachisuka (5) states that G. striata

"was introduced into Seychelles, Madagascar, Mauritius, Réunion, St. Helena, Hawaii and Round Island in West Australia."

In the Philippines McGregor (8) says: "while one of the commonest species in Luzon, occurs but rarely in other islands of the Archipelago."

## OBJECT OF THE STUDY

The object of this study was to determine the food, the amount taken, and the feeding habits of this species in the regions where collecting was done.

#### TIME AND PLACE OF THE WORK

Collecting of specimens covers a period of over a year, from July, 1932, to July, 1933. The difficulties encountered in hunting materials cause the divergence in the number of stomachs obtained monthly for examination.

Collecting was done in fifty-six places in ten provinces, all in Luzon.<sup>2</sup> Observations were made in more places and through a longer period of time than actual collecting.

# RESULTS AND DISCUSSION

Three hundred five stomachs of the barred ground dove were examined. At an early stage of the investigation it became evident that field observations afforded a very useful source of information, this being confirmed by the results of the stomach examination, analyzed volumetrically. (3,7) Since further observations verified those made previously, it was thought best to suspend the destruction of more birds and to draw conclusions from the materials already on hand.

Materials have been examined in all the months of the year except September and January. The birds were obtained either in open fields or in nearby brushlands.

# FIELD OBSERVATIONS

The birds were noted to alight in the open fields, walking, hunting, and picking food. In all observations made, they were not seen to stretch their heads to reach a seed on the stalk. Either seeds on the ground or those close to the ground, which they encounter in their search, comprised their food. During feeding time they rarely go singly, and seldom in a flock of four or six individuals. They are usually in pairs. About harvest time they frequent the rice fields where they feed on rice grains

<sup>&</sup>lt;sup>2</sup> No specimen of this species was seen about Hinigaran, Occidental Negros, in October, 1933.

on the ground. These seeds are abundant after the harvest. consequently the barred ground doves are seen in these places oftener. Due probably to the very soft mud, the barred ground doves do not molest rice seeds in the seed bed. At other times they were noted to feed on the seeds of various species of weeds. While feeding they are cautious, and the approach of a man will cause their sudden flight to the neighboring brush. They were heard cooing in coco groves, but always seen feeding on the ground. These observations confirm those of other workers. McGregor (8) mentions the bird as often feeding in rice fields after harvest. Robinson, who states that in Malay Peninsula it is found searching the ground for seeds, etc., has been cited In India, Mason(6) reported that this species by Baker.(1) feeds "chiefly on seeds on ground." Dammerman, (4) describing the habits of this species in the Malay Archipelago as a whole, states that these birds visit the rice fields only after the harvest to search for the grain left behind.

## EXAMINATION OF STOMACH CONTENTS

The results of the examination of stomach contents indicate that except in one instance when a bird collected in Pililla, Rizal Province, had fed on 170 dipterous pupæ, the food of the species consists of seeds of grain and weeds. The bird's feeding on the insects is considered accidental, although it does not exclude the species from the possibility of being an insectivore.

Table 1 shows that the largest number of collecting grounds <sup>3</sup> from which the greatest number of birds were obtained from a single province is in Rizal. It should also be noted that almost continuous collecting of materials for study was made in this province throughout the year. The reason for this is the accessibility of this province to Manila from where collecting parties were sent out for short periods at occasional intervals. It may be seen that, except in Bulacan Province where 51 per cent of the food of seven birds studied was rice, the bulk of the food of the barred ground dove, by province, consists of weed seeds. In Nueva Ecija, however, the presence of 100 per cent weed seeds in the stomachs of eleven birds may not represent

<sup>\*</sup>For convenience, a collecting ground referred to in this paper is a place where specimens have been obtained each time, thus a particular place may appear 2 in the table if specimens were obtained there at two different periods. Generally, however, collecting was not made at exactly the same spot although within the municipality where ecological conditions are usually uniform.

Province.	Collecting grounds.	Stomachs examined.	Weed seeds in total food.	Rice seeds in total food.
			P. ct.	P. ct.
Pangasinan	7	68	77	23
Zambales	6	23	74	26
Bataan	3	8	64	36
Tarlac	2	4	92	8
Nueva Ecija	3	11	100	
Pampanga	6	36	56.8	43.2
Bulacan	7	53	48.7	51.3
Rizal	15	87	69.6	30.4
Laguna	4	11	87.5	12.5
Ratangas	9	q	95	5

TABLE 1.—Food of the barred ground dove in different provinces.

TABLE 2.—Food of the barred ground dove in different months.

Month.	Stomachs examined.	Weed seeds in total food.	Rice seeds in total food.
		P. ct.	P. ct.
February	71	56	44
March.	10	39.3	60.7
April	4	89	11
May	6	42	58
June	40	90	10
July	80	91.5	8.5
August	13	93.5	6.5
October	15	100	
November	3	7	93
December	113	68.2	31.8

the situation per se as collecting in that province was done only at one time in three places close to each other. The same is true of the materials from Tarlac.

Collecting in Pangasinan, Zambales, and Bataan Provinces was made within one month. Many places distant from each other were, however, involved. In Batangas, collections from three places far from each other, were made within six days.

In Table 2 the highest percentage of grain was recorded in November. This is explained by the fact that the three stomachs examined were obtained from birds shot feeding in a newly harvested rice field in Novaliches, Rizal Province.

The preponderance of rice in the stomachs of the March collection is mainly due to seven birds obtained in Baliuag, Bulacan, and one bird in Apalit, Pampanga, where the birds were noted feeding on the stubble. Examination of six birds col-

lected in May from Bulacan showed a greater percentage of rice seeds than weeds. In Table 1 there is a slight preponderance of the grain over the weeds in the collection from Bulacan. The cause of this is the result obtained from the birds secured during the two months just named and under conditions indicated. It should, however, be noted that in addition to the contents of 15 stomachs collected in October which were entirely weed seeds, 71 stomachs obtained in February, 40 in June, and 113 in December gave 12, 80, and 36 per cent weed seeds, respectively, over the percentage of rice. The figures corresponding to July represent the results of collecting for this month in 1932 and 1933. In July, 1932, only three stomachs were examined and all had nothing but weed seeds.

Collections from Rizal, Pampanga, Tarlac, Pangasinan, Zambales, and Bataan Provinces in December, 1932, resulted in an examination of 113 stomachs, the largest number of specimens studied for any one month.

Examination of 304 stomachs of barred ground doves collected in ten provinces in eleven months over a period of two years indicates that weed seeds comprised 69.9 per cent and rice 30.1 per cent of their food. It is interesting to observe that the results obtained from the examination of stomachs (weeds, 69.6 per cent; rice, 30.4 per cent) in Rizal, which represent the most complete series of materials from any one province, are closer to those of the main results than any of those of the other provinces. It is equally interesting to note the proximity of the average percentages of weeds and rice obtained from the December collection, which represent the largest number of stomachs from many collecting grounds in any one month, to the final results.

The results here obtained, although in accord with those reported by Baker, (1) Dammerman, (4) Mason, (6) and McGregor, (8) perhaps represent the first that are based on actual analysis of the stomach contents of the barred ground dove, G. striata. In Australia similar methods were employed in the study of its congeners, G. humeralis, G. placida, and G. cuneata by Clelland and others, (2) who reported them to subsist on seeds of grain and weeds.

Seeds of the following plants were recorded from stomachs of the barred ground dove:

Tiribúhan: Panicum colonum Linn.

Daua-daúahan; Panicum crus-galli Linn. and P. distachyum Linn.

Sabung-sabungan; P. flavidum Retz.

Luya-luyáhan; Panicum repens Linn.

Laau-láau; Paspalum conjugatum Berg.

Paragis; Paspalum scrobiculatum Linn. and Digitaria corymbosa (Roxb.) Merr.

Tuhog-dalag; Cyperus compressus Linn.

Ballayang; Cyperus difformis Linn., C. iria Linn., and Scirpus articulatus Linn.

Katábad; Scleria tessellata Willd.

Alibangon; Commelina benghalensis Linn.

Alitbangun; Aneilema malabaricum (Linn.) Merr.

Kadayohan; Celosia argentea Linn. Golasiman; Portulaca oleracea Linn.

Mani-manian; Terramus labialis (Linn. f) Spreng.

Tabang-bayawak; Flemingia strobilifera (Linn.) R. Br. and Phyllanthus simplex Retz.

Saluyot; Corchorus capsularis Linn.

Bulubulúhan; Malachra capitata Linn. and Melochia concatenata Linn.

Talanuk; Merremia gemella (Burm. f) Hellier f.

## SUMMARY AND CONCLUSIONS

- 1. Three hundred five stomachs of the barred ground dove were examined. One stomach containing 170 dipterous pupæ was considered accidental and was not included in the estimate.
- 2. The birds were collected in fifty-six places in ten provinces, all on Luzon Island, from July, 1932, to July, 1933.
- 3. Field observations were made in more places and through a longer period of time than actual collecting.
- 4. In the field the birds were noted to feed either on weed seeds and rice grains found on the ground or on seeds obtained close to the ground.
- 5. They were heard cooing in coco groves and in orchards, but seem always to feed on the ground.
- 6. The birds generally go in pairs, seldom singly, and rarely in flocks of four or six.
- 7. The barred ground doves are frequent visitors to rice paddies about harvest time when fallen rice seeds are abundant.
- 8. At other times they feed on seeds of different species of weeds.
- 9. Stomach examination reveals that except for one bird, which fed on dipterous pupæ, the food of the barred ground doves studied consisted of seeds of weeds and rice.
- 10. Due to the accessibility of Rizal Province to Manila from where collecting parties were sent at occasional intervals, a more complete representation of samples compared with other provinces has been obtained from this region.

- 11. The results obtained from the materials collected in Rizal Province follow closely those of the final results.
- 12. An extended collecting trip to secure barred ground doves in December, 1932, resulted in a collection of 112 birds, the largest number for any month.
- 13. The results for December, when the largest number of stomachs for any one month was obtained, are closer to the final results than any of the other months when samples were examined.
- 14. An average of 69.9 per cent weed seeds and 30.1 per cent rice seeds were found to be the constituents of the food of all the barred ground doves studied.
- 15. Seeds of 24 species of weeds were identified from the contents of the stomachs of birds studied.

The food of the barred ground doves has been found, both by field observation and by examination of their stomach contents, to be seeds of rice and weeds. Volumetric analysis indicate that weeds constitute the bulk of their food. The species is a ground feeder and the rice seeds were taken from the stubble. These observations indicate that the species is of neutral importance in its feeding habits.

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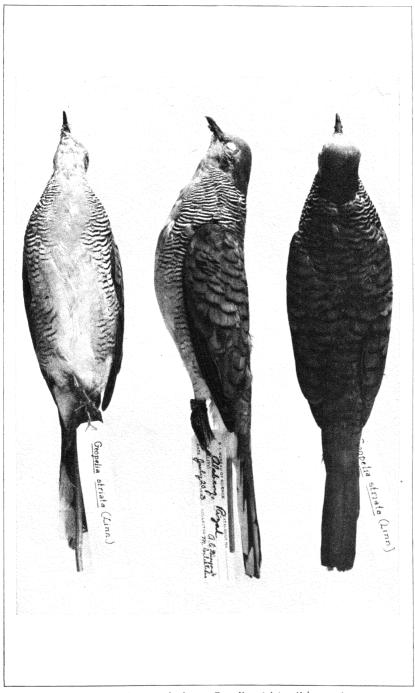
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# **ILLUSTRATION**

PLATE 1. The barred ground dove, Geopelia striata (Linnæus).

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The barred ground dove,  ${\it Geopelia~striata~}$  (Linnæus). PLATE 1.

## METHODS OF SMOKING FISH AROUND MANILA BAY

## By CLARO MARTIN

Of the Fish and Game Administration, Bureau of Science, Manila
TWO PLATES AND THREE TEXT FIGURES

The smoking of fish is an important industry in Manila and in Malabon and Navotas, Rizal Province; and Cavite and Rosario, Cavite Province. The center of the industry in Manila is at Tondo near Bangkusay, one of the principal fish landings in the city. Here, there are thirty smoking sheds, all owned by

Chinese. Outside of Manila smoking of fish is done by Fili-

pinos, most of whom are women.

The Chinese in Manila buy their fish from fishermen of the towns of Navotas and Parañaque, Rizal Province, and Rosario, Cavite Province. Fishermen of Rosario, who are also smokehouse owners, seldom bring their fish to Manila. Their catches are mostly for local smoking. However, they send some surplus brine-cooked fish to the Manila Chinese smokers when they have more fish than they can actually smoke. In Malabon and Navotas the smokers own fish corrals or other kinds of fishing gear. Catches that are not likely to find a market in the fresh condition in Manila are taken home to be salted or smoked.

Retailers in different parts of Manila get their tinapá (smoked fish) from dealers in Divisoria Market. These are all Chinese who are also owners of smoking sheds, if not partners of the smokers. Wholesale buyers from Nueva Ecija, Tarlac, Pampanga, Bulacan, Rizal, Laguna, and Tayabas Provinces deal directly with the smokers in Manila, Malabon, and Navotas.

In Rosario the smokers themselves take their product to the towns of Naic, Indang, Mendez, and Alfonso, Cavite Province, and Nasugbu, a border town of Batangas Province. Occasional orders from San Pablo, Laguna Province, are also received by the smokers. Fish smoked on a small scale by smokers of the town of Cavite are mostly sold locally, although some are sent to Angeles, Pampanga Province, and Cabanatuan, Nueva Ecija Province.

The principal fish used for making tinapa are tamban (Sardinella longiceps), lapád (S. perforata), tonsoy or laolao (S.

fimbriata), and kabasi (Anodontostoma chacunda). The first three are species of the herring family and the fourth is a gizzard shad. All of these are caught in great quantities in Manila Bay from June to December. Silinyasî, the young of tonsoy, is also smoked extensively during March, April, and May. Bañgos, or milkfish (Chanos chanos), is sometimes smoked.

# METHOD OF SMOKING EMPLOYED IN MANILA

Preparing the brine.—The preparation of brine is very simple. A large tub is filled with water and into this is poured the salt in small quantities. After each addition the water is stirred vigorously. The process is continued until a saturated solution of brine is obtained. Although this is an easy way of preparing the brine, the resulting solution is by no means clean. The local commercial salt is far from being free from dirt. Some dirt floats with the foam on the surface, while the rest settles to the bottom with the undissolved grains of salt.

Brine has the property of drawing blood from the fish, and the extracted blood mixes with the solution. After a time the original brine becomes saturated with fish blood and slime. When the fish have been removed, the scales and heads that may have fallen off are dipped out. The same brine is usually used over and over again for months without change. More salt is added from time to time as occasion demands.

Brining the fish.—Brining is a measure to prevent the spoilage of the fish while awaiting to be brine-cooked. The fish are brined in the round; that is, the heads and entrails are not removed. Brining the fish without washing is a general practice among the smokers. After the brining tub has been filled to capacity, the brine and fish are stirred and handfuls of salt are spread to cover the fish on the surface. Fish 10 to 14 centimeters long are immersed twenty minutes before brine-cooking; silinyasî 4.5 to 8 centimeters long, five minutes.

Brine-cooking.—The fish from the brining tub are placed in small immersion baskets (kaing) with a capacity of 7 to 8 kilograms. These baskets are provided with a pair of long rattan handles by which they are suspended during immersion in the boiling brine. Only one or two baskets can be placed in the kettle at a time.

The baskets are immersed about 15 centimeters below the surface of the brine in a large iron kettle having a capacity of about 95 liters. The kettle is mounted on a stone or concrete

furnace 1.7 meters square and 1.5 meters high. A rectangular hole on one side of this furnace serves both as opening of the fire box and also as smoke flue. The attendant stands at the side opposite the opening.

The time for which fish of different sizes are cooked varies. The smaller the fish the shorter the period, as shown in the following table:

Kind of fish.	Langth of cooking period.  Min.
Silinyasî of all sizes	1.3 to 1.5
Tonsoy	2.5 to 3
Lapád	2.5 to 3
Tamban	3 to 4.5
Kabasi	4 to 5

The weaker solution of brine is used for small fish like silinyasî. For larger fish like tamban and kabasi, a stronger solution is used. A considerable amount of saturated brine clinging to the fish from the brining tank goes into the kettle and thus helps raise the concentration of the cooking-brine. As constant evaporation also makes this brine more concentrated, fresh water is added to it occasionally during the cooking process to dilute the brine and fill the kettle. It usually takes at least three hours to finish brine-cooking all the fish in a tub of about 400 kilograms.

Smoking.—After brine-cooking, the baskets are placed on the floor to allow the fish to cool. When cool, the fish are arranged in round bamboo trays (titai). These are of two sizes, 7 by 46 centimeters, holding 50 kabasi or tamban and 100 tonsoy or lapád, and 6 by 36 centimeters, holding 50 tonsoy or lapád. Large fish are generally arranged overlapping one another. Silinyasî, 6 to 7.5 centimeters long, are scattered loosely in a helter-skelter arrangement. In the case of the smaller silinyasî, 4.5 to 5 centimeters long, the trays are filled to the brim. These are partially sundried before being placed in the smoking trays. In the drying yard they are placed on flakes 56 by 113 centimeters, made of coarsely woven thin strips of bamboo. Large fish are dried in the same trays in which they are smoked Fish that are brine-cooked in the afternoon are allowed to stand in the trays overnight and smoked the following morning. In this manner partial drying is accomplished without exposure to the sun. Partial drying hardens the fish to a certain extent and prevents breakage during subsequent handling. In emergency cases fish are smoked without being partially dried.

The smoking furnace, usually made of blocks of adobe stone, is about 23 meters long, 1 meter wide, and 70 centimeters high. This is built on one side of the shed, never in the middle. It may be straight or it may assume any shape, depending on the shed where it is built. It is provided with 28 to 30 smoking chambers, 35 to 37 centimeters in diameter, 24.5 to 28 centimeters apart. The depths range from 80 to 82 centimeters. Each smoking hole is fueled with sawdust independently. The air necessary for the combustion in the smoking chamber is admitted through an opening 3.2 centimeters in diameter placed in front, 25.5 centimeters from the top. Crumpled paper plugged in these openings loosely or tightly, as the case may be, serves to regulate the amount of air admitted to the smoking chamber.

Charcoal is made to glow usually in the last unit of the furnace. Occasionally a specially constructed unit may be found separate and not far from the furnace. Glowing charcoal is placed at the bottom of each hole and then covered with sawdust of tangili [Shorea polysperma (Blanco) Merrill], or red lauan (Shorea negrosensis Foxworthy), or a mixture of the two. In front of the furnace are placed tubs of sawdust convenient to the attendant.

One to two trays of fish are placed over each opening. They are covered with round bamboo baskets 19 centimeters deep and 58.5 centimeters in diameter to confine the smoke about the fish. The period of smoking varies with the size of the fish and the kind of product, whether intended for local markets or for provincial retailers. Generally the larger the fish the longer the exposure to the smoke. Products sent to the provinces must keep longer and therefore must be smoked longer than those intended for the local markets. The following table shows the length of smoking for the different kinds of fish:

Kind of fish.	Length of smoking period. Mins.
Silinyasî (4.5 to 6 centimeters long)	135 to 140
Silinyasî (6 to 8 centimeters long)	30 to 40
Tonsoy	45 to 60
Lapád	60 to 105
Kabasi	100 to 110
Tamban	100 to 120

<sup>\*</sup> These small fish are packed thickly in the tray and cannot be thoroughly and uniformly smoked within a short time. They are turned over four times during the process, at intervals of at least 25 minutes, so that the time of smoking is lengthened.

At intervals of 10 to 40 minutes, depending upon the temperature and the kind of fish, the trays are shifted and additional sawdust is dropped into each hole. In shifting, the tray on the first hole is placed to the rear, then a heaping handful of sawdust is dropped in before the tray from the next opening is placed on it. The contents of the tray is slightly shaken in order to prevent the fish from sticking to each other and to the bottom of the tray. In case there are two trays over a hole, the one below is placed on top of the other.

After smoking, the trays are removed and placed on the floor to cool. Sometimes the exposed side of the fish is smeared with olive oil to give it a glossy appearance. When the furnace is used continuously for two or three days the temperature rises to as high as 150° C. The heat is not maintained at a uniform temperature. Soon after sawdust is added, the temperature goes down, to rise again gradually. The lowest temperature taken was 77° C. The furnace cools after two or three days' stop in the operation. In this event the smoking period is lengthened 15 to 20 minutes and more sawdust is used.

Packing.—Smoked fish for the local trade are not packed for delivery to the market. They are taken to the Divisoria market, the distributing center for tinapa in Manila, by carriers in the trays in which they were smoked. For provincial wholesale buyers who purchase the product direct from the smokers, the fish are packed in coarsely woven bamboo baskets with the sides and bottom lined with several layers of newspapers. Before packing the fish must be allowed to cool completely. If this is not done, the moisture in the fish is prevented from escaping, so that the fish become very soft and are liable to become moldy in a short time, especially during rainy days.

#### SMOKING OF FISH OUTSIDE MANILA

In Malabon and Navotas fish are smoked in the same way as in Manila.

The method used by the smokers in Cavite, Cavite Province, is an adaptation on a small scale of the Manila method. Instead of a long furnace, individual *pilones* <sup>1</sup> set in upright position are used as smokers. The usual number of pilones in a shed is six. Another deviation from the Chinese practice is that the brine in which the fish are immersed before cooking

¹ These are muscovado containers made of baked potter's clay. They are shaped like beehives with a round hole on top.

after being used twice, at the most, is discarded and a fresh lot is prepared. The brining tubs are also kept very clean.

The following method is used in Rosario, Cavite Province:

Cleaning and drying.—Before being taken to the shore the fish are washed in sea water to remove the dirt and slime. The carrier does the washing in the baskets on the way to the shore. The fish are then arranged to be partially dried under the sun on pieces of banatan or baklad, 1 by 2.5 meters long. These banatan which serve as flakes are made of small rounded splints of bamboo, "woven together with three to five lacings of hagnaya (Polygala venenosa Tuss.)." When the scales and the skin of the side exposed are sufficiently dry, the fish are turned over to dry the other side.

Partial drying is necessary in order to dry the scales and toughen the skin. Moisture in the scales causes them to fall off during cooking. The belly of unbrined fish breaks usually when cooked wet.

Brine-cooking.—From the drying yard the fish are taken to the smoking shed to be cooked in strong brine. Sea water is used in preparing the brine. When the cooking is over the clear liquid is stored in a tub to be used the next time. This brine is used over and over again with the addition of salt and sea water.

A kettle of 95-liter capacity is generally used. It is filled to within 4 centimeters of the brim. The fish are placed a few at a time into the boiling brine, and allowed to stay there five to seven and one-half minutes. To keep the fish submerged, a circular traylike affair, called panakip, made of bamboo, is placed over them with a weight. Every now and then the floating scum is scooped off. A paddle-shaped, flat spoon (panandok) (fig. 1) made of perforated copper sheet, is used in taking the fish out. From the kettle the fish are placed on a bamboo flake (kapeng) to drain and cool. After cooling they are arranged on racks (daleyráyan) (fig. 2) ready for smoking.

Smoking.—A shallow pit with a circular wall of earth, stone, or concrete serves as the smoker. The inside of the pit is formed like a shallow bowl, so much so that the whole affair looks like a large mortar (fig. 3). The height of the wall with a varying thickness of 22 to 28 centimeters does not exceed 67 centimeters. The individual holes are from 94.5 to 167 centimeters inside diameter and 70 to 77 centimeters deep from the top of the wall. A large round bamboo basket 21 centimeters

deep is used as a cover to confine the smoke in the smoking chamber. This basket has a rim diameter 10 centimeters greater than the inside diameter of the hole. Above the open-



Fig. 1. Panandok.

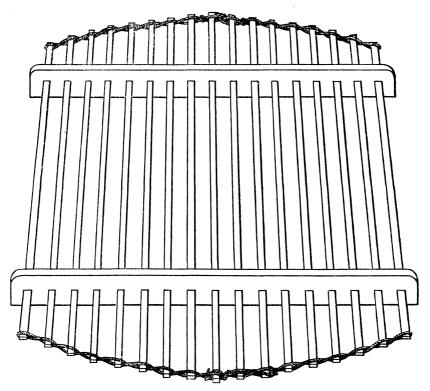


Fig. 2. Daleyráyan.

ning are suspended two hooks which serve as supports for the cover when the hole is opened.

The rack (daleyráyan) on which the fish are smoked consists of a number of bamboo sticks thrust through two wooden frames. The fish are arranged side by side on their backs at

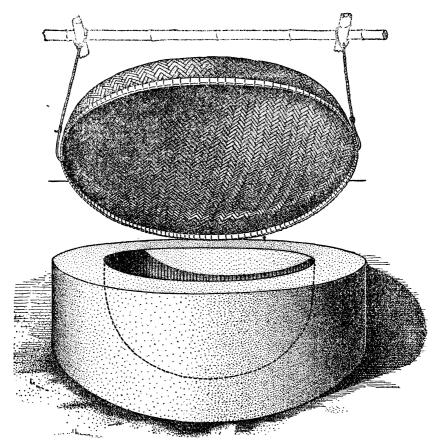


Fig. 3. Smoking hole used in Rosario, Cavite Province.

right angles with the sticks. The smallest rack holds 1,000 fish and the largest 1,500 to 1,800.

The rack is placed on the hole and covered. The rim of the cover is slightly raised in front in order to admit the necessary air for combustion. Instead of sawdust, sugar-cane bagasse and wood chips are used, the former being the main fuel. The smoke is watched, and when no longer dense, more fuel is added. After forty to sixty minutes smoking the rack is taken out. The fish are reset in order to prevent them from sticking to each other. They are again smoked for practically the same length of time.

The temperature of the smoking chamber taken immediately below the center of the rack ranges from 110° to 130° C. during the operation.

#### REMARKS

The tinapa is a clean product when it has been cooked and smoked properly. Improperly prepared, tinapa will not keep well. To turn out a product of acceptable quality, smokers, of Manila particularly, should pay more attention to sanitation. In Manila the fish are immersed in brine without washing and the same old brine is used over and over again for months. Although strong, this brine is saturated with fish blood and slime and is thus dirty and unfit for use. The floors of the smoking sheds, with the exception of a few which are paved with concrete, are bare earth. This is true not only in Manila but also in Malabon, Navotas, Cavite, and Rosario. Also the placing of brine-cooked fish in trays or on racks and the cooling and packing of the smoked product are done on dirty floors.

Of all smoking sheds visited only those in Rosario are neat, clean, and roomy. The elimination of the brining before brine-cooking and the use of a single smoking hole with a much greater capacity are factors that contribute to ease in maintaining the neatness of the shed. Although they employ the same method as that used by the Chinese in Manila, the smokers of Malabon, Navotas, and Cavite handle the fish in a more sanitary manner.

#### RECOMMENDATIONS

Brining the fish without washing off the slime and dirt should be avoided. Fresh clean brine should be always used. After being used once or twice, the brine should be discarded and the tub cleaned. Brine can be prepared by the use of two tubs (barrels will do) and a large wooden tank set at different levels. The first tub is kept filled with salt. Water flowing continuously but slowly is admitted from its bottom. The saturated brine that overflows from it is collected in the second tub where the dirt settles. The overflow from this settling tub is collected in the wooden tank. It is more convenient to place these brine containers on an elevated platform. In this manner it will be easier to draw the brine from the tank to any part of the shed by means of a hose.

The use of clean, pure salt for all purposes should be encouraged. Pure salt penetrates the fish flesh readily and thus brings about quicker preservation.

The common practice is to use old, dirty newspapers for wrapping and cheap, coarsely woven bamboo baskets lined with newspapers for packing smoked fish. This practice should be discouraged and smokers should be taught to follow the modern method of using transparent paper for wrapping and carton or wooden boxes for packing.

For the sake of cleanliness and the comfort of the workers, working tables should be provided by all means. The floor of the shed should be paved with concrete and washed frequently.

The lack of discrimination on the part of the buying public and the apathy of the fish smokers towards modern ways and methods are factors hindering the improvement of the locally produced smoked fish. The public health authorities should frame regulations that will improve the sanitary condition of the smoking sheds and the quality of the product. More frequent inspections of the smoking sheds and proper enforcement of sanitary regulations in the municipalities and in Manila along the line mentioned above will elevate fish-smoking to a sanitary and profitable industry.

## **ILLUSTRATIONS**

#### PLATE 1

- Fig. 1. Placing brined fish in immersion baskets for brine-cooking. (Taken at Manila.)
  - 2. The furnace with the kettle where the fish are brine-cooked. (Taken at Manila.)

#### PLATE 2

- Fig. 1. Brine-cooked fish (kabasi) being partially dried under the sun in trays before smoking. (Taken at Manila.)
  - 2. Interior of a smoking shed showing the smoking furnace, tubs of sawdust, and a pile of empty trays. The trays on the left foreground have just been removed from the furnace. (Taken at Manila.)

#### TEXT FIGURES

- Fig. 1. Panandok.
  - 2. Deleyráyan.
  - 3. Smoking hole used in Rosario, Cavite Province.



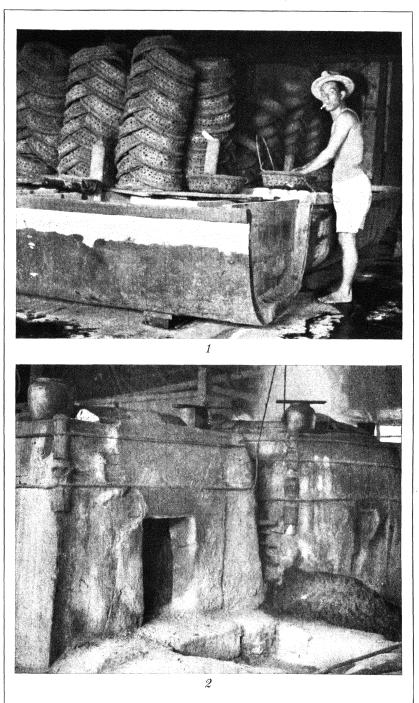


PLATE 1.



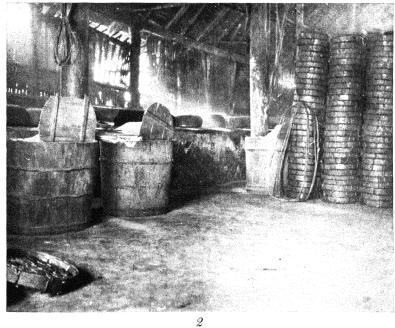


PLATE 2.

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# HUMAN INFESTATIONS WITH ASCARIS AND TRICHURIS IN DIFFERENT PARTS OF THE PHILIPPINE ISLANDS

By Marcos A. Tubangui, Mariano Basaca, and Antonio M. Pasco Of the Division of Biological Products, Bureau of Science, Manila

#### FOUR TEXT FIGURES

Recently the writers made a quantitative survey of human intestinal parasites in different places in the Philippines in connection with an investigation on the anthelmintic efficiency of hexylresorcinol against Ascaris lumbricoides, Trichuris trichiura, and hookworms. The data obtained have been compiled and those on ascaris and trichuris are presented in this paper. Although there already exists a large volume of literature on the occurrence of these parasites in the Philippines, these available records are mostly in the form of incidence statistics. cent surveys made in other parts of the world have shown that data of this sort do not portray accurately the true picture of parasitic infestations, for they do not distinguish between cases that are only slightly infested and those that are heavily parasitized. On the other hand, quantitative data, such as those obtained by the Stoll egg-counting technic, express the probable worm burden of an infested individual or of a population, for which reason they are considered more trustworthy and more useful in epidemiological surveys, especially in measuring the efficiency of treatments and control measures.

#### PLACES SURVEYED AND TIME OF YEAR

The bulk of our work was carried out in three places during different times of the year as follows: in Manila from July 25

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to September 23, 1932; in Pardo, Cebu, from April 10 to 30, 1933; and in Paombong, Bulacan, from May 15 to June 3, 1933. It was planned to conduct the survey in more than one locality in order to find as great a variety of cases as possible for treatment with hexylresorcinol and at the same time to have an opportunity to determine some of the factors which might be involved in the distribution of intestinal parasites in the Philippines. The places mentioned were selected as representative of three distinct areas differing in social, sanitary, and economic development. Manila is a big city with a modern public-health service and represents, therefore, a typically urban environment. Pardo and Paombong, on the other hand, are rural communities lacking approved sanitary conveniences. The method of waste disposal in these two communities is primitive. As far as we were able to ascertain, in neither of the three places visited had there been conducted any worthwhile campaign against intestinal parasites during the last five years.

#### MATERIALS AND METHODS

The total number of persons examined was 1,393 distributed as follows: 503 in the City of Manila, 489 in Pardo, Cebu, and 401 in Paombong, Bulacan. Those examined in Manila were school children, 7 to 11 years of age and studying in the Magdalena Elementary School; those in Pardo and Paombong represented mixed populations.

Individual fæcal samples were collected in ordinary Petri dishes between two circular pieces of paraffined paper. The purpose of the latter was to facilitate the cleaning of the dishes. Uusally from forty to fifty of these containers were distributed in the afternoons and collected on the following mornings. As soon as the specimens were received in the laboratory, they were classified as to consistency and then prepared for egg-counting according to the displacement method of Stoll and Hausheer (1926). In recording the egg counts the figures were brought to the formed basis (Stoll, 1929) and corrected for size (Cort, Otto, and Spindler, 1930).

#### RESULTS OF EGG COUNTS FOR ASCARIS

For purposes of comparison the results of the fæcal examinations are given separately for each area surveyed. In Table 1 is shown the incidence of ascaris infestation and the egg counts analyzed according to age and sex.

Pardo, Cebu, Cebu.—Of the 489 persons examined 253 were males and 236 females. The males showed an ascaris incidence of 80.2 per cent and an average count of 15,960 eggs per cc of fæces. The incidence in the females was slightly lower, 78.8 per cent, but the average count was higher or 17,780 eggs per The incidence in the entire Pardo series was thus 79.5 per cent and the average egg count 16,800 per cc. These figures, if corrected for a standard population according to the suggestion. of Sweet (1929), would be as follows: the incidence in the males 80.7 per cent and the average egg count 14,750 per cc; the incidence in the females 79.5 per cent and the average egg count 17,250; the incidence in both sexes 78.1 per cent and the average count 16,000 per cc. Considering only the positive cases in order to indicate the intensity of the infestations, the averages were 20,200 eggs per cc in the two sexes, 18,400 in the males alone and 22,000 in the females. These are fairly high egg counts, the corrected figures indicating an average worm burden of 16 adult ascaris in the entire series of 489 individuals.<sup>1</sup> They approximate those obtained by Cort, Stoll, Riley, and Sweet (1929) in Panama, but our incidence percentages are much higher than those of the Panama series. They are also higher than most of the incidence percentages published by the earlier workers in the Philippines. Among the latter only Garrison, Leynes, and Llamas (1909) and Willets (1913) in surveys conducted in Taytay, Rizal, and in the Batanes Islands. respectively, reported incidences of ascaris infestations of a little over 79.5 per cent.

The characteristic distribution of ascaris in a mixed population is clearly shown in Table 1. When the individuals examined are classified into conventional age groups, the incidence of the parasite is much higher in younger than in older persons, the percentage of infestation being 95.9 per cent in the 196 individuals up to 14 years of age and only 68.5 per cent in the remaining 293 persons 15 years old and over. The same difference is observed between the two groups in regard to their egg counts, the average worm burden of the younger individuals being more

<sup>&</sup>lt;sup>1</sup> From the egg counts the probable number of adult ascaris harbored by an individual may be estimated by dividing the number of eggs per cc. of stools by 1,000. In the use of this factor it is considered that the egg production per adult female ascaris is 2,000 per cc of fæces and the number of male and female worms approximately equal (Cort and Stoll, 1931).

TABLE 1.—Results of egg counts for ascaris classified according to age and sex. The figures in parentheses represent the average counts of positive cases only.

ALES.

Years.         Cases.         Positive. dence. dence	Average egg count per cc. 14,150 (15,100) (24,800) (35,230 (36,010) 12,000 (15,300) 6,510 (9,940)		Positive. 19 34 17 17 14	Incidence.  P. ct. 73.1 100.0 89.5 82.3	Average egr count per cc. 11,280 (15,430) 23,990 (23,990)	Савев.	Positive.	Inci- dence.	Average egg count per cc.
16 15 93.7 44 42 95.4 46 46 97.8 23 18 78.2 29 19 65.5 27 18 66.6	14,150 (15,100) 23,680 (24,800) 35,230 (36,010) 12,000 (15,300) 6,510 (9,940)	26 34 10	19 34 17 8	P. cf. 73.1 100.0 89.5 80.0	11,280 (15,430) 23,990 (23,990)				
16     15     93.7       44     42     95.4       46     45     97.8       23     18     78.2       29     19     65.5       27     18     66.6       11     9     81.8	14,150 (15,100) 23,680 (24,800) 35,230 (36,010) 12,000 (15,300) 6,510 (9,940)	26 34 10 10	19 34 17 18	73.1 100.0 89.5 80.0	11,280 (15,430) 23,990 (23,990)			P. ct.	-
44     42     95.4       46     45     97.8       23     18     78.2       29     19     65.5       27     18     66.6       11     9     81.8	(15,100) 23,680 (24,800) 35,230 (36,010) 12,000 (15,300) 6,510 (9,940)	19	34 17 18 8	89.5 80.0	(15,430) 23,990 (23,990)			1	
44     42     95.4       46     45     97.8       23     18     78.2       29     19     65.5       27     18     66.6       11     9     81.8	23,680 (24,800) 35,230 (36,010) 12,000 (15,300) 6,510 (9,940)	19	34 17 8	89.5 80.0	23,990 (23,990)				
46     46     97.8       23     18     78.2       29     19     65.5       27     18     66.6       11     9     81.8	(24,800) 35,230 (36,010) 12,000 (15,300) 6,510 (9,940)	10	17 8	80.0	(23,990)	166	137	82.5	26,340
23 18 78.2 29 19 65.5 27 18 66.6 11 9 81.8	35,230 (36,010) 12,000 (15,300) 6,510 (9,940)	10	17 8	80.0					(39,910)
23 18 78.2 29 19 65.5 27 18 66.6 11 9 81.8	(36,010) 12,000 (15,300) 6,510 (9,940)	10	8 14	80.0	44,230	93	8	86.0	31,320
23 18 78.2 29 19 65.5 27 18 66.6 11 9 81.8	12,000 (15,300) 6,510 (9,940)	10	8 41	80.0	(49,430)				(36,410)
29 19 65.5	(15,300) 6,510 (9,940)	ţ	14	85	21,600				
29 19 65.5	6,510 (9,940)		14	82.3	(27,000)				
27 18 66.6	(9,940)	=		,	8,330			1	
27 18 66.6		**********			(10,110)				
11 9 81.8	6,700	22	15	0.09	5,780				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
11 9 81.8	(8,540)				(9,630)				o de la companya de l
(10	8,750	16	9	62.5	10,020				
	(10,700)				(16,040)				
85-39 17 12 70.6 6,	(086,9	-	4	57.1	8,260		-		
(6)	(8,820)				(14,450)				
40-44	3,880	16	9	37.6	6,120		-		
(1)	(4,760)				(16,330)				
45-49	15,000	9	ю	83.3	15,870	:			
(23)	(23,500)				(19,040)				de giorn
60+	6,070	23	<b>œ</b>	34.8	5,030	1		1	
(8)	(8,880)				(14,460)				
Total or average	15,960	199	140	70.3	14,960	259	217	83.8	28,090
(19)	(19,900)				(20,700)				(33,570)

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0- 4	18	17	94.4	15,400	19	15	78.9	18,610	1			
				(16,300)	•			(23,580)				
5- 9.	53	8	100.0	32,700	ន្ត	55	95.6	23,790 (24,870)	155	131	84.5	25,710 (30,420)
10–14	43	40	93.0	28,350 (30,470)	83	56	9.68	22,880 (25,520)	83	77	86.5	86,530 (41,750)
15-19	23	16	9.69	15,100 (21,720)	82	23	82.1	20,410 (24,840)				
20-24	27	18	9.99	12,300 (18,400)	20	19	95.0	21,440 (22,570)				
25-29	22	19	76.0	12,900	20	14	70.0	7,930 (11,330)				
30-84	18	14	77.7	18,950 (24,370)	12	7	58.3	10,500 (18,000)	1		!	
35-39	13	6	69.2	10,680 (15,420)	13	80	61.5	8,680 (14,100)				
40-44	æ	4	50.0	4,900	10	9	0.09	2,880 (4,800)	1		:	
45-49	œ	4	50.0	17,350 (34,700)	4	89	20.0	2,900 (5,800)	!		:	
	24	16	9.99	3,780 (5,680	4	16	66.7	12,520 (18,770)	;			;
Total or average	236	186	8.82	17,780 (22,560)	202	158	78.2	16,850 (21,800)	244	802	85.2	29,660 (34,790)

than twice that of the older ones. As a matter of record the highest individual counts in the two sexes were 137,600 and 160,800 eggs per cc and were met with in a boy 10 years old and in a girl 11 years old, respectively.

A comparison of the counts of the different age groups is shown graphically in text figure 1. In the males the average

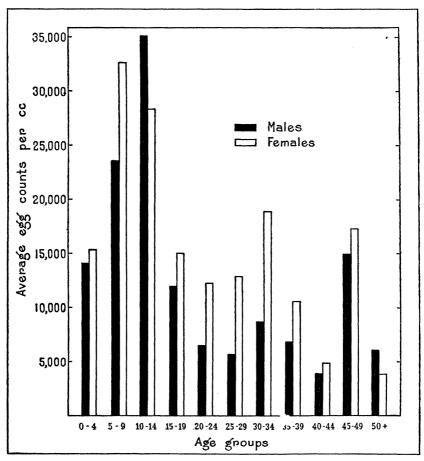


Fig. 1. Showing average ascaris egg counts of Pardo series. See Table 1.

count of 14,150 eggs per cc in the group 0 to 4 years old is comparatively high, but the counts are much higher in the next two groups, the peak of the egg count curve occurring in the 10- to 14-year group and representing an average of 35,230 eggs per cc. The curve then falls abruptly in the 15- to 19-year group and continues to fall in the succeeding age groups with no tendency to rise except in the 45- to 49-year group. In the fe-

male series the average counts are also high in the younger groups, the peak of the curve occurring in the 5- to 9-year group and representing 32,700 eggs per cc. In the 10- to 14-year group the curve drops slightly to 28,350 eggs per cc. Then there is a sudden drop to 15,100 in the 15- to 19-year group, but in contrast to what has been observed in the males, the curve is maintained more or less at that level in the succeeding groups, except in the 40- to 44- and 50-year and over groups. The average egg count of females over 15 years old is about twice that of males of the same age.

Table 2.—Ascaris infestations of Pardo series classified according to intensity groups.

#### Ascaris infestation groups Ages 0-14 yrs. Ages 30-44 yrs. Ages 45+yrs. All ages. 15-29 yrs. in eggs per cc. P. ct. P. ct. P. ct. P. ct. P. ct. 4 3.8 24 30.4 12 31.6 10 33.3 50 19.8 Negative\_\_\_\_\_ 36 33.9 37 46.9 50.0 43.3 105 41.5 1-10,000\_\_\_\_\_ 19 13 16.7 45.3 20.2 29.6 10,001-50,000 -----48 16 6 15.8 Б 75 12.3 2.5 1 2.6 2 7.1 50,001-100,000\_\_\_\_\_ 13 2 6.7 18 100,001+-----5 4.7 0 0 0 0 5 0 2.0 100.0 100.0 100.0 100.0 Total\_\_\_\_ 106 38 30 100.0 253 FEMALES. 22 29.3 37.5 Negative\_\_\_\_\_ 4 4.4 12 30.8 12 50 21.2 1-10,000\_\_\_\_\_ 32 35.6 25 33.3 14 35.9 15 46.9 86 36.4 36 40.0 24 10,001-50,000\_\_\_\_\_ 32.0 10 25.6 4 12.5 74 31.4 3 0 50,001-100,000 -----15 16.7 4.0 2 5.1 20 8.5 100,001+-----3.3 1 1.3 1 2.6 1 3.1 2.5 100.0 100.0 99.9 100.0 100.0 Total\_\_\_\_\_

#### MALES.

In Table 2 an analysis of the individual infestations into intensity groups is fiven. Here again the same differences already noted in the distribution of ascaris in a mixed population are evident. In the first place it is shown that about 60 per cent of all the persons examined, 73 per cent of those at least 15 years of age, and only 38 per cent of those up to 14 years old, fall in the negative and lowest egg count groups, in which the estimated number of adult worms harbored is not more than 10. On the other hand, there were 49 cases in the highest egg count groups, that is, those with more than 50,000 eggs per cc, of which 36 or 73 per cent were met with in young individuals up to 14 years old. These 36 cases represent only

about 7.4 per cent of the 489 persons examined, but the sum of their egg counts constitutes 60 per cent of that of the entire series. Considering the sexes separately, of the males 7.1 per cent, all of them young, carry 55 per cent of the total worm burden of the males and of the females 7.6 per cent carry 62 per cent of the total count of the females. These findings are in accord with those of other workers who observed that there is a tendency in ascaris infestation for a large percentage of the worm burden to be concentrated in a small number of individuals. This, according to Cort (1931), is due to the fact that a combination of factors, such as, grossly polluted sources of infestation and very poor personal hygiene which are necessary to produce very heavy infestations, are rarely met with. The explanation given for the greater prevalence of the parasite in children is that the latter are more exposed to infestation on account of their playing on the ground and of their generally more insanitary habits.<sup>2</sup> Women of child-bearing age have also greater chances of being infested than adult males due to their closer association with children and to the greater proportion of time that they spend in and around the house. Curiously enough in our series the average count of women of child-bearing age is very similar to that of children between 0 and 4 years old.

Paombong, Bulacan.—As shown in Table 1, of the 401 individuals who were egg-counted in this town, 74.3 per cent were found positive for ascaris, the percentage being 70.3 per cent in the 199 males and 78.2 per cent in the 202 females. As in the Pardo series, the incidence was higher in the younger individuals, the infestation among 150 persons up to 14 years of age being 88.7 per cent and only 65.7 per cent among the 251 persons 15 years old and over. The average egg count of the entire series is 15,860 per cc, being 14,960 for the males and 16,350 for the females. These figures, if corrected for a standard population, would be 16,300 for both males and females, 16,800 for the males alone and 15,750 for the females. If the positive cases alone are considered, the average count of

<sup>&</sup>lt;sup>a</sup> We have inquired into the possible sources of ascaris and trichuris infestations in Manila and Paombong by examining soil samples and other suspected objects for the embryonated ova of the two parasites according to the method of Caldwell and Caldwell, as described by Spindler (1929). Our findings conform with those of Brown (1927) and Otto, Cort, and Keller (1931) in that they point to soil pollution in the immediate surroundings of houses as the chief source of infestation.

the two sexes is 21,050, of the males alone 20,700 and of the females 21,300. In both males and females the average counts are comparatively high in the younger individuals, the peak of the average egg count curve occurring between 10 and 14 years in the males and between 5 and 9 years in the females. In the males the average counts become gradually smaller from the 15th year on; while in the females they are conspicuously high between 15 and 24 years, after which the curve is maintained at a low level as in the males.

Table 3.—Ascaris infestations of Paombong series classified according to intensity groups.

MALES.

Negative   8											
Negative         9         11.4         15         28.8         19         48.7         16         55.2         59           1-10,000         22         27.8         21         40.4         12         30.8         7         24.1         62           10,001-50,000         41         51.9         15         28.8         5         12.8         5         17.2         66           50,001-100,000         4         5.1         1         1.9         3         7.7         1         3.5         9           100,001+         3         3.8         0         0         0         0         0         3         3           FEMALES.           FEMALES.           Negative         8         11.3         12         17.6         14         40.0         10         35.7         44           1-10,000         27         38.0         28         41.2         10         28.6         9         32.1         74           10,001-50,000         29         40.8         20         29.4         11         31.4         7         25.0         67           50,001-100,000         4         <										Al	l ages.
1-10,000			P. ci.		P. ct.		P. ct.	promise, and	P. ct.		P. ct.
10,001-50,000	Negative	9	11.4	15	28.8	19	48.7	16	55.2	59	29.7
50,001-100,000       4       5.1       1       1.9       3       7.7       1       3.5       9         100,001+       3       3.8       0       0       0       0       3       3         Total       79       100.0       52       99.9       39       100.0       29       100.0       199         FEMALES.         Negative       8       11.3       12       17.6       14       40.0       10       35.7       44         1-10,000       27       38.0       28       41.2       10       28.6       9       32.1       74         10,001-50,000       29       40.8       20       29.4       11       31.4       7       25.0       67         50,001-100,000       4       5.7       8       11.8       0       1       3.6       13         100,001+       3       4.2       0       0       1       3.6       4	1-10,000	22	27.8	21	40.4	12	30.8	7	24.1	62	31.1
100,001+	10,001-50,000	41	51.9	15	28.8	5	12.8	5	17.2	66	33.2
Total 79 100.0 52 99.9 39 100.0 29 100.0 199 FEMALES.  Negative 27 38.0 28 41.2 10 28.6 9 32.1 74 10,001-50,000 29 40.8 20 29.4 11 31.4 7 25.0 67 50,001-100,000 4 5.7 8 11.8 0 11 3.6 13 100,001+ 3 4.2 0 10 1 3.6 4	50,001-100,000	4	5.1	1	1.9	3	7.7	1	3.5	9	4.5
FEMALES.       Negative	100,001+	3	8.8	0		0		0		3	1.5
Negative       8       11.3       12       17.6       14       40.0       10       35.7       44         1-10,000       27       38.0       28       41.2       10       28.6       9       32.1       74         10,001-50,000       29       40.8       20       29.4       11       31.4       7       25.0       67         50,001-100,000       4       5.7       8       11.8       0       1       3.6       13         100,001+       3       4.2       0       0       1       3.6       4	Total	79	100.0	52	99.9	39	100.0	29	100.0	199	100.0
1-10,000     27     38.0     28     41.2     10     28.6     9     32.1     74       10,001-50,000     29     40.8     20     29.4     11     31.4     7     25.0     67       50,001-100,000     4     5.7     8     11.8     0     1     3.6     13       100,001+     3     4.2     0     0     1     3.6     4				FE	MALES	•					
10,001-50,000 29	Negative	8	11.3	12	17.6	14	40.0	10	35.7	44	21.8
50,001-100,000 4 5.7 8 11.8 0 1 3.6 13 100,001+ 3 4.2 0 0 1 3.6 4	1-10,000	27	38.0	28	41.2	10	28.6	9	32.1	74	36.6
100,001+	10,001-50,000	29	40.8	20	29.4	11	31.4	7	25.0	67	33.2
	50,001-100,000		5.7	8	11.8	0		1	3.6	13	6.4
Total 71 100.0 68 100.0 35 100.0 28 100.0 202	100,001+	3	4.2	0		0		1	3.6	4	2.0
	Total	71	100.0	68	100.0	35	100.0	28	100.0	202	100.0

An analysis of the egg counts into intensity groups, as given in Table 3, shows that 59.6 per cent of all individuals examined, 68.9 per cent of those at least 15 years of age, and only 44 per cent of those between 0 and 14 years old, were found to be either free from ascaris or to have an average worm burden estimated to be not more than 10 adult parasites. As in the Pardo series, the greater bulk of the infestation was found concentrated in a few individuals (29 cases), 48.2 per cent of whom were young persons not over 14 years of age. These 29 cases constitute only 7.2 per cent of the 401 persons examined, but their total egg count represents more than 40 per cent of that of the entire series.

Manila.—As shown in Table 1, of the 503 school children examined in Manila 84.5 per cent were positive for ascaris, the

incidence being 83.8 per cent in the 259 boys and 85.2 per cent in the 244 girls. The average count of the entire series was 28,870, of the boys alone 28,090, and of the girls 29,660 eggs per cc of fæces. Considering only the positive cases, the average counts were 34,180 in both sexes, 33,570 in the males and 34,790 in the females.

Table 4.—Ascaris infestation in 503 school children (ages 7 to 11 years) in Manila, arranged according to intensity groups.

Ascaris infestation group in eggs per cc.	М	ales.	Fe	males.
		Per cent.		Per cent.
Negative	42	16.2	36	14.7
1-10,000	65	25.1	58	23.8
10,001-50,000	104	40.2	102	41.8
50,001-100,000	30	11.6	37	15.2
100,001+	18	6.9	11	4.5
Total	259	100.0	244	100.0

An analysis of the counts into intensity groups, as given in Table 4, shows that about 40 per cent of all the children examined belonged to the negative and lowest egg-count groups and only 19 per cent to the highest egg-count groups. The total count of the latter represents nearly 60 per cent of that of the entire group. Considering the sexes separately, 18.5 per cent of the boys had 58 per cent of the total count of all of the boys and 19.7 per cent of the girls had 59 per cent of the count of all of the girls. These figures show that even in a series composed entirely of school children there is a tendency for the greater bulk of the infestation to be concentrated in a limited number of individuals.

#### RESULTS OF EGG COUNTS FOR TRICHURIS

The data available for the study of trichuris infestation represent the results of the examination of the same individuals from which the ascaris counts were obtained. As in the case of the latter, they are given separately according to population groups for purposes of comparison (Table 5).

Pardo, Cebu, Cebu.—Of the 489 persons examined 431, or 88.1 per cent, were positive for trichuris, the incidences in the males and in the females being exactly the same. The average egg count of the entire series was 4,400, of the males alone 4,120, and of the females 4,630. These data would be as follows, if corrected for a standard population: Incidence in the

entire series 87.7 per cent, in the males alone 86.8 per cent, and in the females 88.6 per cent; egg count of the entire series 3,900, of the males alone 3,500, and of the females 4,300. Considering only the positive cases the average counts were 4,970 in the two sexes, 4,680 in the males and 5,260 in the females.

It will be noticed from the data presented in Table 5 that with the exception of the males between 30 and 34 years the

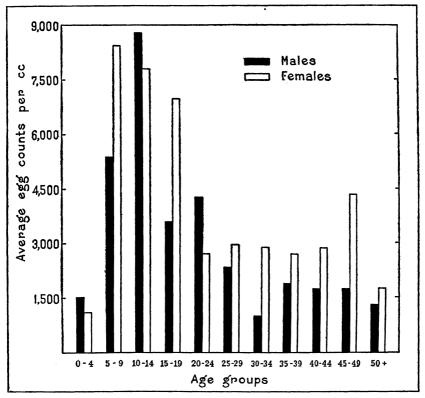


Fig. 2. Showing average trichuris egg counts of Pardo series. See Table 5.

incidence of trichuris in the various age groups is uniformly high, the differences occurring between the younger and older individuals not being as significant as those observed in ascaris infestations. With respect to the average egg counts, however, the same age and sex differences as were encountered in ascaris infestations are evident (text fig. 2). In both sexes the egg counts were low in young children between 0 and 4 years, the peak of the egg count curve in the males occurring between 10 and 14 years and in the females between 5 and 9 years. In

The figures in parentheses represent the TABLE 5.—Results of egg counts for trichuris classified according to age and sex. average counts of positive cases only.

IALES.

		Pardo	Pardo, Cebu.			Paombon	Paombong, Bulacan.	j.		M	Manila.	
Аge group.	Cases.	Positive.	Inci- dence.	Average egg count per cc.	Cases.	Positive.	Inci- dence.	Average egg count per cc.	Cases.	Positive.	Inci- dence.	Average egg count per cc.
Years.			P. ct.				P. ct.				P. ct.	
0- 4	16	14	87.5	1,520	56	10	38.5	230				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
				(1,730)				(009)				and the second
6-9	44	43	97.7	5,370	34	56	76.5	1,380	166	144	86.7	2,400
				(2,500)				(1,810)		•		(2,770)
10-14	46	46	100.0	8,800	19	12	63.2	2,000	93	83	89.2	4,200
		er roller och		(8,800)				(3,170)				(4,700)
15-19	53	. 12	91.3	3,600	10	10	20.0	1,560				
		Provide a real		(3,940)				(3,120)				w.mp.co
20-24	29	24	82.7	4,280	17	12	9.07	1,010	1		1	
				(5,170)				(1,430)				
25-29	27	20	74.1	2,340	22	13	52.0	069		• ;	1	1
	-			(3,160)				(1,380)				
30-34	п	9	54.5	1,020	16	o	56.3	770				1
	-			(1,870)				(1,380)				
35-39	17	15	88.2	1,900	7	70	71.4	1,140		-	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
				(2,160)		_		(1,600)				
40-44	10	∞	80.0	1,740	16	10	62.5	820				
				(2,170)				(1,320)	-			
45-49	Ħ	10	6.06	1,760	9	'n	88.3	1,000	1			
				(1,940)				(1,200)				-
20+	19	16	84.2	1,340	23	11	47.8	450		-	-	
				(1,500)				(940)				
Total or average	253	223	88.1	4,120	199	118	59.3	096	259	227	87.6	3,040
				(4,680)				(1,620)	-	- Marie - Land		(3,480)
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		155 131 84.5	91.0 3,050								
		-		0 1,850					400		_
52.6		91.3	55.2	75.0	50.0		41.7	46.1	50.0	50.0	
10		21	16	21	10	9	LO	9	10	63	
19		23	29	58	20	50	12	13	10	4	_
1,100	(1,240)	8,450	7,820	7,000	2,720	(3,900)	2,910 (3,360)	2,710 (2,710)	2,900	4,350	
88.8		96.5	88.4	78.3	88.8	76.0	83.3	100.0	100.0	100.0	
16		28	38	18	24	19	15	13	∞	<b>∞</b>	3
18		29	43	23	27	25	18	13	00	∞	6
0- 4		5- 9-	10-14	16-19	20-24	25-29	80–34	35-39	40-44	46-49	+02

the males there is observed a marked reduction after the fourteenth year while in the females the drop occurs at least five years later. A comparison of the egg counts of adult individuals shows that the trichuris burden of the females is nearly twice as great as that of the males. These differences are most probably due to the same factors which have been mentioned as responsible for the distribution of ascaris in a mixed population, considering that both parasites have simple life cycles and identical modes of transmission.

Table 6.—Trichuris infestations of Pardo series classified according to intensity groups.

Trichuris infestation group in eggs per cc.		Ages 4 yrs.		Ages 29 yrs.		Ages 44 yrs.		Ages +yrs.	Al	l ages.
		P. ct.		P. ct.		P. ct.		P. ct.		P. ct.
Negative	3	2.8	14	17.7	9	23.7	4	13.3	30	11.9
1-1,000	19	17.9	21	26.6	13	34.2	9	30.0	62	24.5
1,001-2,500	18	17.0	18	22.8	9	23.7	14	46.7	59	23.3
2,501-5,000	22	20.8	8	10.1	3	7.9	1	3.3	34	13.4
5,001+	44	41.5	18	22.8	4	10.5	2	6.7	68	26.9
Total	106	100.0	79	100.0	38	100.0	30	100.0	253	100.0
			FF	MALES						
Negative	8	8.9	14	18.7	3	7.7	3	9.4	28	11.9
1-1,000	15	16.7	15	20.0	5	12.8	11	34.4	46	19.5
1,001-2,500	18	20.0	13	17.3	16	41.0	6	18.7	53	22.4
2,501-5,000	13	14.4	13	17.3	8	20.5	8	25.0	42	17.8
5,001+	36	40.0	20	26.7	7	18.0	4	12.5	67	28.4
Total		100.0	75	100.0	20	100.0		100.0	000	100 0

#### MALES.

An analysis of the individual infestations into intensity groups, as given in Table 6, shows that 34 per cent of all the persons examined, 23 per cent of those between 0 and 14 years of age, and 61.7 per cent of those 15 years old and over, were either free from trichuris or only very slightly infested, as judged by their egg counts which were not more than 1,000 per cc of stools. In the heavily infested groups, that is, those with counts of more than 2,500 eggs per cc, there were 211 cases, of which 115 or 54.5 per cent were young individuals up to 14 years of age. These 115 cases had a total count representing 66 per cent of that of the entire series; but since they constitute 23.5 per cent of all the persons examined, it is shown that in trichuris infestations the tendency which has been observed in

ascaris infestations for the bulk of the worm burden to be concentrated in a small number of persons, does not occur. The highest individual counts were 56,000 and 60,000 in a 20-year-old male and in a 13-year-old female, respectively.

Paombong, Bulacan.—Of the 401 persons examined in this town 234, or 58.1 per cent, were positive for trichuris, the incidence in the 199 males being 59.3 per cent and in the 202 females 57.4 per cent. The average egg count of the entire series was 890, of the males alone 960, and of the females 820. These data would be as follows, if corrected for a standard population: Incidence in the entire series 58.4 per cent, in the males alone 59.3 per cent, and in the females 57.5 per cent; egg count of the entire series 890, of the males alone 1,020, and of the females 760. These are low averages compared with those of the Pardo series and seem to indicate that there are certain factors existing in Paombong, Bulacan, which operate against the development of heavy trichuris infestations.

Table 7.—Trichuris infestations of Paombong series classified according to intensity groups.

#### Trichuris infestation Ages 0-14 yrs. Ages Ages 30-44 yrs. Ages All ages. 15-29 yrs. 45 + yrs.group in eggs per cc. P. ct. P. ct. P. ct. P. ct. P. ct. Negative\_\_\_\_\_ 31 39.2 22 42.3 15 38.4 44.8 13 81 40.7 28.8 1-1,000\_\_\_\_\_ 26 32.9 15 12 30.8 34.5 10 63 31 7 1,001-2,500\_\_\_\_\_ Я 21.2 10.1 11 10 25.6 5 17.2 34 17.1 2,501-5,000\_\_\_\_\_ 10 12.7 1 1.9 1 2.6 1 3.5 13 6.5 5,001+-----3 4 5.15.8 1 2.6 0 4.0 Total\_\_\_\_\_ 100.0 100.0 100.0 100.0 199 100.0 FEMALES. 24 33.8 31 45.6 54.3 Negative\_\_\_\_\_ 19 12 42.8 86 42.6 1-1,000\_\_\_\_\_ 27 38.0 24 35.3 12 34.3 11 39.3 74 36.6 15.5 7.3 1,001-2,500 11 5 4 11.4 5 17.9 25 12.4 2,501-5,000\_\_\_\_\_ 8.5 5 7.30 0 11 5.4 3 5,001+-----3 4.2 4.4 0 0 6 3.0 Total.... 100.0 99.9 100.0 100.0 100.0

#### MALES.

An analysis of the individual counts into intensity groups, as given in Table 7, shows that nearly 76 per cent of the whole series belong to the negative and lowest egg count groups and only 9.5 per cent to the highest egg count groups. In the latter most of the counts were between 3,000 and 6,000, the only ex-

ceptions being the counts of 8,000 and 17,600 in a 10-year-old male and in a 19-year-old female, respectively.

Manila.—Of the 503 children examined, 439 or 87.3 per cent were positive for trichuris, the percentage in the 259 boys being 87.6 per cent and in the 244 girls 86.9 per cent. The average egg count of the entire series was 2,940, of the males alone 3,040, and of the females 2,810. If only the positive cases are considered, the average count of the whole group was 3,360, of the boys 3,480, and of the girls 3,240. An analysis of the counts into intensity groups, as given in Table 8, shows that 218 children, or 43 per cent, were either free from trichuris or only lightly infested with counts not exceeding 1,000 per cc of fæces and that 170 cases, or 34 per cent, were either moderately or heavily parasitized each with a count of more than 2,500 eggs per cc. The combined count of the latter constitutes nearly 80 per cent of that of the entire group, showing that in this, as in the Pardo series, the bulk of the infestation is not concentrated in such a small number of individuals as was found to be the case in ascaris infestation. The highest individual counts were 73,000 and 19,200 in a boy 11 years old and in a girl 12 years old, respectively.

TABLE 8.—Trichuris infestation in 503 school children (ages 7 to 11 years) in Manila, arranged according to intensity groups.

Trichuris infestation group in eggs per ec.	М	ales.	Fe	males.
		Per cent.		Per cent
Negative	32	12.4	32	13.1
1-1,000	84	32.4	70	28.7
1,001-2,500	61	23.5	54	22.1
2,501-5,000	36	13.9	46	18.9
5,001+	46	17.8	42	17.2
Total	259	100.0	244	100.0

## COMPARISON OF THE ASCARIS AND TRICHURIS INFESTATIONS OF THE THREE POPULATION GROUPS EXAMINED

One would expect, as in fact it has been claimed due to apparently favorable climatic conditions, the distribution in the Philippines, especially in the unsanitated rural districts, of the common intestinal worms of man to be more or less uniform. Some of the earlier workers in tropical medicine in the Islands, however, must have suspected that such is not the case, for a number of them conducted surveys in widely separated places, obviously to learn something of the local geographical distribu-

tion of these parasites. Unfortunately very little progress in this direction was made, solely because of the fact that the apparently more accurate methods of field investigation which are now available were then unknown. Willets (1914) in particular examined cases from practically every province in the Archipelago, but the data he collected were only incidence statistics, from which he was unable to draw worthwhile conclusions. He merely noted that the distribution of the various intestinal parasites was extremely irregular, that in many instances very different results were obtained from adjacent northern and adjacent southern provinces.

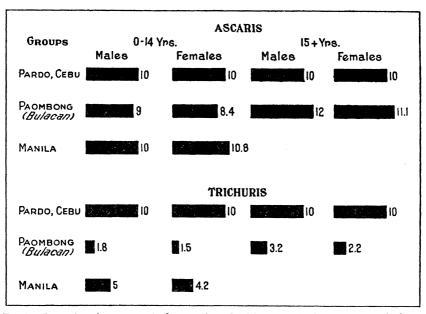


Fig. 3. Comparing the egg counts for ascaris and trichuris of the Pardo series with those of the Manila and Paombong series.

As stated in an earlier section of this paper, it has been shown by recent investigations that for epidemiological purposes quantitative data based on the egg output of intestinal worms are more accurate than incidence statistics. This being the case, a comparison of our three sets of egg counts for ascaris and trichuris with each other should give more valuable information regarding the distribution of these parasites in the Philippines. Such a comparison is shown in text figure 3, in which the average counts for the two parasites of children (0 to 14 years old) and adults (15 years and over) in the Pardo series,

classified according to sex, are each given a weight of 10 and the ratio to this figure of each of the corresponding counts in the Manila and Paombong series is calculated. It is evident from the bar diagrams that in the case of ascaris there are not very noticeable differences in the distribution of the parasite. the degree of infestation being about the same in the three It is true that in the Paombong series the children show a slightly smaller worm burden, but the deficiency is made up by the somewhat higher counts of the adults. In the case of trichuris the differences are very marked, the average worm burden of those from Pardo being nearly five times as heavy as that of the Paombong group and about twice that of the The significance of these observations is that Manila series. in the three places where the examinations were conducted the conditions were equally favorable for the propagation of ascaris while the factors favoring the dissemination of trichuris were present to a greater extent in Pardo than in either Manila or Paombong.

To explain this difference in the distribution of the two parasites, reference should be made to the recent studies by Spindler (1929) and Otto (1929) on the biology of the eggs of these worms. According to these authors the ova of ascaris and trichuris are both resistant to many external conditions, but with the difference that the ova of trichuris are more easily destroyed by dessication and require more moisture for development than those of ascaris. It is suggested that this difference is probably the main reason why ascaris is so widely prevalent in different parts of the world while trichuris is mostly limited to those warm places where the soil is damp during the greater part of the year. The prevalence of ascaris in the Philippines could be explained in a similar manner, but to what extent the question of moisture enters as a factor in the local distribution of trichuris can only be determined by considering the amount and distribution of the annual rainfall and the effect of the shade of trees and other vegetation on the conservation of ground According to Father Coronas (1920) the monthly distribution of the annual rainfall in the Philippines may be classified into four types as follows: first type, in which there are two pronounced seasons—dry in winter and spring and wet in summer and autumm; second type, in which there is no dry season, with a very pronounced rain period in winter; third or intermediate A type, in which there is no very pronounced

rain period, with a short dry season lasting only for one to three months; fourth or intermediate B type, in which there is no very pronounced rain period and no dry season. Manila and Paombong are included among the regions having the first type and Pardo among those having the third type of rainfall distribution. Text figure 4 shows that although the annual rainfall of Pardo (1,530 mm) is less than that of either Manila (1,963 mm) or Paombong (2,103 mm)<sup>3</sup>, it is more evenly distributed between the different months. Besides, there is in Pardo an abundance of coconut trees, especially around the houses, in contrast to the sparse vegetation in Manila and Paombong.

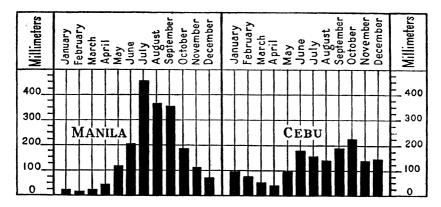


Fig. 4. Showing the monthly distribution of rainfall in Manila and Cebu. (From Coronas in the 1918 Census of the Philippine Islands.)

These factors taken together suggest a more uniform moisture content in the soil at Pardo, while in the other two places the soil is either too wet or too dry depending upon the time of the year. In other words there is in the former locality sufficient moisture throughout or during the greater part of the year for the development of trichuris eggs, while in Manila and Paombong the ground is so dry during certain months that trichuris ova are destroyed. For this reason the danger of building up heavy trichuris infestations is greater in Pardo than in the other two places.

<sup>\*</sup>These data on annual rainfall are taken from the 1918 Census of the Philippine Islands. The information for Pardo is judged from the records of the climatological station at Cebu, which is about 6 kilometers from Pardo, that for Paombong from the records of the station at Marilao, which is about 22 kilometers from Paombong.

#### SIGNIFICANCE OF ASCARIS COUNTS OF CHILDREN IN MANILA

It was noted above that the egg counts for ascaris of children in Manila were as high as those of children in Pardo and Paombong, indicating the presence in these three places of sources of infestation to which the people are exposed. This finding calls for some comment in view of the fact that Manila with its modern system of waste disposal should possess certain sanitary advantages over Pardo and Paombong, which are not as well The inference, therefore, is that not all of the members of the community in Manila take advantage of the available sanitary facilities, as otherwise soil pollution could not occur and the propagation of the parasite could not take place to the extent suggested by the high egg counts (see footnote 2 on In this connection our observations made in some of the poorer and more crowded sections of the city, where the large majority of the children examined reside, have shown that, as in most other places where ascariasis prevails, it is the children, especially those of preschool age, who are mainly responsible for the pollution of the ground. And since it has been shown that it is the children who are most subject to ascariasis, the conclusion is that they are mostly responsible for the spread of the parasite. For this reason, as pointed out by Cort (1933), in any campaign against ascariasis, if successful results are to be expected, special efforts must be exerted to control the promiscuous defecation of young children.

#### SUMMARY

A quantitative parasitological survey by means of the Stoll egg counting technic was conducted in three different places in the Philippine Islands in connection with an investigation on the anthelmintic efficiency of hexylresorcinol against the common intestinal worms of man. A total of 1,393 persons were examined, distributed as follows: 489 in Pardo, Cebu, Cebu; 401 in Paombong, Bulacan, Luzon; and 503 in the City of Manila. Those from Pardo and Paombong were mixed populations, while those from Manila were school children 7 to 11 years old.

The results of the egg counts for ascaris were as follows: Pardo series, incidence 79.5 per cent, average count 16,800 eggs per cc of fæces; Paombong series, incidence 74.3 per cent, average egg count 15,860; Manila series, incidence 84.5 per cent, average egg count 28,870.

The results of the egg counts for trichuris were as follows: Pardo series, incidence 88.1 per cent, average egg count 4,400; Paombong series, incidence 58.1 per cent, average egg count 890; Manila series, 87.3 per cent, average egg count 2,940.

An analysis of the counts for ascaris showed that in a mixed population the incidence is higher and the degree of infestation heavier in children (0 to 14 years old) than in adults (15 years old and over), that it is more prevalent and heavier in females of child-bearing age than in males of corresponding age, and that the greater bulk of the worm burden is concentrated in a small percentage of individuals, most of whom are children.

An analysis of the counts for trichuris showed that the parasite has practically the same age and sex distribution in a mixed population as ascaris, but the worm burden was more evenly distributed than in ascaris infestation.

A comparison of the three sets of count with each other showed no important differences in the intensity of ascaris in the three places where the survey was conducted, while in the case of trichuris the infestations were decidedly heavier in those from Pardo than in those from either Manila or Paombong. This difference in the distribution of the two parasites is ascribed to the difference in the resistance of their eggs. The ova of ascaris are resistant to many unfavorable external conditions, for which reason the parasite is very widely distributed. The ova of trichuris are easily destroyed by dessication, for which reason the danger of contracting heavy infestations with the parasite is greater in regions where, due to the distribution of the annual rainfall and the presence of covering vegetation, the ground is damp during the greater part of the year.

It was determined that ascaris infestation in the Philippines is due to soil pollution around the houses. In view of this, the high incidence and intensity of the parasite in Manila, where there is a modern system of waste disposal, is taken as an indication that not all of the members of the community utilize the available sanitary facilities. Observations made in some of the poorer and more crowded sections of the city, where the majority of the children examined reside, showed that it is the children of preschool age who are mainly responsible for the pollution of the soil. For this reason in any campaign against ascaris, in order to produce successful results, special efforts should be exerted to control the promiscuous defecation of children.

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## **ILLUSTRATIONS**

#### TEXT FIGURES

- Fig. 1. Bar diagrams showing average ascaris egg counts of Pardo series. See Table 1.
  - 2. Bar diagrams showing average trichuris egg counts of Pardo series. See Table 5.
  - 3. Bar diagrams comparing the egg counts for ascaris and trichuris of the Pardo series with those of the Manila and Paombong series.
  - Bar diagrams showing the monthly distribution of rainfall in Manila and Cebu. (From Coronas in the 1918 Census of the Philippine Islands.)

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## NEMATODES IN THE COLLECTION OF THE PHILIPPINE BUREAU OF SCIENCE, II: FILARIOIDEA

#### By MARCOS A. TUBANGUI

Of the Division of Biological Products, Bureau of Science, Manila

#### FOUR PLATES

The nematode superfamily Filarioidea comprises an interesting group of parasites, of which the following species have already been reported from the Philippines: Wuchereria bancrofti of man, Dirofilaria immitis of dogs, Setaria equina of horses, S. labiato-papillosa of cattle, Elwophora poeli of cattle and carabaos, and Diplotriwna corrugata of the bird Ptilocichla basilanica. In the present paper are described six new members of the group, one of which was collected from cattle and the rest from birds. I wish to thank Dr. Zacarias de Jesus, of the Philippine Bureau of Animal Industry, for presenting the parasite from cattle, and Miss Victoria A. Masilungan, of the Bureau of Science, for much technical assistance.

Family FILARIIDÆ (Cobbold, 1864) Claus, 1885

Subfamily FILARIINÆ Stiles, 1907

PARAFILARIA BOVICOLA sp. nov. Plate 1, figs. 1 to 3.

Several specimens of this filaria were collected by Doctor Zacarias de Jesus, of the Bureau of Animal Industry, from native cattle presenting skin lesions that answer the description of those reported in horses and which are associated with a parasite very closely related to *Parafilaria multipapillosa* (Condamine and Drouilly, 1878). Only two of the specimens are complete for purposes of description and both are females. Doctor de Jesus, who is interested in the parasite from the pathological standpoint, has under observation an infested animal; if he should succeed in recovering male worms, a more complete description of the nematode than is given below will be forthcoming.

A comparison of the material at hand with the female of *Parafilaria multipapillosa*, as described by Railliet and Moussu (1892) and as figured by Yorke and Maplestone (1926), has

brought out the following differences: the eggs of the Philippine species as well as the inclosed embryos are smaller and the cuticular adornment at its anterior end appears quite distinct in that the papillalike structures behind the mouth that are characteristically numerous in *P. multipapillosa* are limited in number, there being more transverse cuticular prominences or ridges.

Specific diagnosis.—Parafilaria: Male unknown.

Female: Body whitish, 40 to 50 millimeters in length by 0.40 millimeter in maximum diameter. Anterior extremity conical, adorned for the most part with prominent, transverse, cuticular ridges interrupted at irregular intervals, and at its tip with a limited number of small roundish tubercles or papillalike structures; the rest of the cuticle is distinctly striated, the striations being 3.5 to 4 microns apart.

Mouth small, with two inconspicuous lateral lips and surrounded by four small papillæ, of which one pair is lateral and the other median. Œsophagus weak, 0.23 to 0.25 millimeter long, communicating with mouth through a short narrow vestibule; intestine prominent, its posterior end including anus atrophied. Nerve ring at or very near middle of œsophageal length. Cervical papillæ inconspicuous, behind level of œsophagus, 0.28 to 0.30 millimeter from anterior end. Uteri convergent, meeting at level about 0.7 millimeter from anterior end to form the vagina. Vulva close to mouth, 54 to 56 microns from anterior end. Eggs very thin-shelled, embryonated, 40 to 52 by 27 to 33.2 microns in size; the inclosed larvæ are provided with a short taillike process and are 160 to 190 by 5 to 6 microns in size. Posterior end rounded, with a pair of minute papillæ, one on each side of subterminal anus.

Host.—Native cattle.

Location.—Skin nodules.

Locality.—Tanauan, Batangas, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 427.

Subfamily DIPLOTRIÆNINÆ Skrjabin, 1916 DIPLOTRIÆNA PYCNONOTI sp. nov. Plate 2, figs. 1 and 2.

The material available for description consists of one male and four female worms collected from *Pycnonotus goiavier*. The parasite appears to be very closely related to *Diplotriæna corrugata*, a Philippine species reported by Wehr (1930) from the body cavity of the bird *Ptilocichla basilanica*. It differs

from the latter, however, as well as from the other members of the genus Diplotriæna by the number and arrangement of its genital papillæ. In D. corrugata there are, according to Wehr, seven or eight papillæ near the tip of the posterior end of the body, while in the species under consideration there are definitely three pairs of ventral postanal papillæ.

Specific diagnosis.—Diplotriæna: Body cylindrical, tapering towards both extremities which, however, are rounded. Cuticle transversely striated in both sexes. Mouth a simple opening without lips, surrounded by two lateral and four submedian papillæ. Œsophagus very long, inconspicuously divided into a short anterior and a long posterior portion and carrying at its anterior extremity a pair of lateral chitinous structures or tridents. Teeth of tridents with transverse external corrugations, at least on distal two-thirds of their lengths; they often vary in length, the middle one of a set usually shorter. Nerve ring immediately in front of junction of anterior and posterior portions of œsophagus.

Male: Length 22 millimeters, maximum diameter 0.5 millimeter. Œsophagus 3.10 millimeters in total length, its anterior portion 0.35 millimeter long. Tridents 0.14 millimeter long. Nerve ring 0.25 millimeter from anterior end of body. Cloacal opening 0.11 millimeter from posterior end which is rounded and without lateral wings. Genital papillæ three pairs, all postanal, ventral, and provided with short peduncles. Spicules unequal: right spicule characteristically twisted at proximal and distal thirds of its length and measuring 0.55 millimeter in length by 45 microns in maximum diameter across its proximal end; left spicule slightly bent but not twisted, more pointed distally than its fellow, and measuring 0.78 millimeter in length by 60 microns in maximum diameter across its proximal end.

Female: Length 30 to 48 millimeters by 0.60 to 0.72 millimeter in maximum diameter. Œsophagus 3.4 to 4.0 millimeters in total length, its anterior portion 0.36 to 0.40 millimeter long. Tridents 0.17 to 0.19 millimeter long. Nerve ring 0.30 to 0.34 millimeter from anterior end. Vulva much behind junction of two œsophageal regions, 0.54 to 0.78 millimeter from anterior end. Eggs moderately thick-shelled, embryonated when ready to pass out of body, 45.7 to 47.8 by 31.2 to 33.2 microns in size.

Host.—Pycnonotus goiavier.

Location.—Subcutaneous tissue (below crop).

Locality.—Sipocot, Camarines Sur, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 411.

Subfamily SETARIIN Æ Yorke and Maplestone, 1926 SERRATOSPICULUM THORACIS sp. nov. Plate 1, fig. 4; Plate 3, figs. 1 to 4.

According to the arrangement of their genital papillæ, the known members of the genus Serratospiculum Skrjabin, 1916, may be conveniently divided into two groups as follows: (a) those possessing at least five and (b) those with less than five preanal genital papillæ. To the first group belong S. turkestanicum Skrjabin 1916, S. helicinum (Molin, 1858) Walton, 1927, and S. chungi Hoeppli and Hsü, 1929; and to the second group S. tendo (Nitzch, 1857) and S. guttatum (Schneider, 1866), as described by Seurat (1915). The parasite in question, which is represented by two males and six females, is affiliated with the two latter species, differing from them in the greater size of its body and the length of its spicules.

Specific diagnosis.—Serratospiculum: Body elongate, bluntly conical anteriorly and more or less rounded posteriorly in both sexes. Caudal extremity of female straight, that of male curved ventrally and provided with short lateral wings. Mouth elongate dorsoventrally, with two insignificant lateral lips, each supported by a small epauletlike structure, subdivided into three areas each connected with a papilla. There are in addition two other papillæ on each side so that there are in all five pairs of mouth papillæ, the arrangement of which is shown in Plate 3, fig. 2. Œsophagus divided into a short, narrow anterior part and a long, broad posterior part which gradually tapers posteriorly. Nerve ring near middle of length of anterior portion of æsophagus. Cervical papillæ 0.28 to 0.30 and excretory pore 0.32 to 0.35 millimeter from anterior end.

Male: Length 150 to 160 millimeters, maximum diameter 0.46 to 0.58 millimeter. Œsophagus 11.3 to 14.5 millimeters in total length, its narrow anterior part about 0.4 millimeter long. Testis coiled a number of times around junction of anterior and posterior portions of œsophagus. Cloacal opening 0.12 to 0.15 millimeter from posterior end. There are ten pairs of genital papillæ and a median unpaired papilla immediately anterior to cloacal opening. The paired papillæ are arranged as follows: four pairs preanal, of which two pairs are lateral and pedunculated, and two pairs ventral and sessile; six pairs postanal, of which three pairs are lateral and pedunculated and three pairs

ventral and sessile. The two spicules are very unequal: left spicule 1.1 to 1.3 millimeters long, transversely striated and swollen behind middle of its length with a maximum diameter of 0.16 millimeter, and jointed between anterior and middle thirds of its length; right spicule 0.48 to 0.50 millimeter long, its posterior half winged and distinctly serrated.

Female: Length 185 to 315 millimeters, maximum diameter 0.64 to 0.80 millimeter. Œsophagus 14.4 to 15.0 millimeters in total length, its narrow anterior portion 0.4 to 0.5 millimeter long. Vulva with prominent lips, 1.00 to 1.12 millimeters from anterior end. A well-developed ovejector present. Eggs moderately thick-shelled, those found in ovejector embryonated and measuring 50 to 54 by 33.2 microns. Anus posterosubterminal, about 50 microns from posterior end.

Host.—Falco ernesti.

Location.—Embedded in walls of thoracic and abdominal cavities.

Locality.-Manila, P. I.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 404.

# HAMATOSPICULUM OTOMELARUM sp. nov. Plate 4, figs. 1 to 4.

This species is represented in the collection by four males and two females. Following the lead of Sandground (1933), it is assigned to the genus *Hamatospiculum* Skrjabin, 1916, in spite of the presence of a cephalic cap (epauletlike structure), for in other morphological characters it agrees with the description of that genus. Compared with the other members of the genus it appears to be most similar to *H. quadriens* (Molin, 1858), as described by Boulenger (1928), but differs from it in the length of its spicules and the number of its caudal papillæ.

Specific diagnosis.—Hamatospiculum: Body cylindrical, tapering toward both extremities. Anterior end in both sexes rounded. Cuticle faintly striated transversely. Mouth a simple terminal opening bounded laterally by a pair of toothlike structures and five pairs of papillæ which in their arrangement have the appearance of an epauletlike structure (Plate 4, fig. 2). Esophagus divided into a short anterior portion and a long posterior portion. Nerve ring across middle of anterior portion of œsophagus or immediately anterior to that level.

Male: 25 to 27 millimeters long by 0.50 to 0.54 millimeter in maximum diameter. Œsophagus 6.2 to 6.5 millimeters in total

length, its anterior portion 0.28 to 0.30 millimeter long. Posterior end rounded, with narrow alæ meeting posteriorly. Spicules very unequal; right spicule 0.33 to 0.37 millimeter in length by 29 microns in maximum width at proximal end; left spicule filiform, 2.95 to 3.15 millimeters by 33.3 microns in size. Genital papillæ six pairs, with very short peduncles and arranged as follows: four pairs preanal and ventral and two pairs postanal and lateral. Cloacal opening about 80 microns from posterior end.

Female: 82 to 90 millimeters long by 0.86 to 0.95 millimeter in maximum diameter. Œsophagus 9 to 11.2 millimeters in total length, its anterior portion 0.38 to 0.44 millimeter long. Vulva with prominent lips, 1.10 to 1.35 millimeters from anterior end. Anus about 80 microns from posterior end. Eggs moderately thick-shelled, embryonated when ready to be deposited, 52 to 56 by 33.2 to 35.6 microns in size.

Host.—Otomela lucionensis.

Location.—Under skin of head and neck and between trachea and esophagus.

Locality.—Baao, Camarines Sur, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 428.

## HAMATOSPICULUM LETICIÆ sp. nov. Plate 2, fig. 4.

This species is represented in the collection by two males and two females, one of which is badly damaged and therefore unfit for description. It is distinguished from *Hamatospiculum otomelarum* by its genital papillæ, of which there are five preanal pairs and three postanal pairs.

Specific diagnosis.—Hamatospiculum: Shape of body, structure of esophagus, and arrangement of mouth papillæ as in H. otomelarum.

Male: 16 to 24.5 millimeters in length by 0.45 to 0.52 millimeter in maximum diameter. Total length of esophagus 9.9 to 11.4 millimeters, its anterior portion 0.28 to 0.31 millimeter long. Posterior end rounded, with short narrow alæ meeting posteriorly. Spicules unequal: right spicule 0.265 to 0.300 millimeter in length by 25 microns in maximum width; left spicule 2.5 to 2.7 millimeters by 23 microns in size. Genital papillæ eight pairs, pedunculated and arranged as follows: five pairs preanal, and ventral; three pairs postanal, of which the second pair is ventral and the rest lateral. Cloacal opening about 50 microns from posterior end.

Female: 72 millimeters in length by 0.8 millimeter in maximum diameter. Total length of œsophagus 16.2 millimeters, its anterior portion 0.40 millimeter long. Vulva 1.0 millimeter from anterior end. Anus about 70 microns from posterior end. Eggs moderately thick-shelled, embryonated when ready to be oviposited, 47 to 54 by 31.2 to 33.3 microns in size.

Host.—Halcyon chloris.

Location.—Under skin of head and neck.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 429.

HAMATOSPICULUM DICRURI sp. nov. Plate 2, fig. 3.

This worm is represented in the collection by three males and five females. It differs from the preceding two species as well as from the other members of the genus *Hamatospiculum* in being smaller and in the number of its genital papillæ.

Specific diagnosis.—Hamatospiculum: Shape of body, structure of esophagus, and arrangement of mouth papillæ as in the two preceding species.

Male: 22 to 25 millimeters in length by 0.5 to 0.7 millimeter in maximum diameter. Œsophagus 5.5 to 7.3 millimeters in total length, its anterior portion 0.29 to 0.32 millimeter long. Posterior end rounded with poorly developed alæ. Spicules unequal: right spicule 0.32 to 0.38 millimeter in length by 23 to 25 microns in maximum diameter; left spicule 2.4 to 2.9 millimeters by 25 to 29 microns in size. Genital papillæ nine pairs, pedunculated and arranged as follows: six pairs preanal and ventral; three pairs postanal, of which the first pair is ventral and the rest lateral. Cloacal opening 75 to 80 microns from posterior end.

Female: 38 to 54 millimeters in length by 0.60 to 0.85 millimeter in maximum diameter. Œsophagus 7.8 to 8.4 millimeters in total length, its thin anterior portion 0.32 millimeter long. Vulva with prominent lips, 0.92 to 1.00 millimeter from anterior end. Anus about 80 microns from posterior end. Eggs moderately thick-shelled, embryonated when ready to be deposited, 52 to 57.5 by 31.2 to 33.2 microns in size.

Host.—Dicrurus balicassius.

Location.—Under the skin of head.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 430.

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# **ILLUSTRATIONS**

#### [Drawn by Mr. Alfredo C. Gonzales.]

#### PLATE 1

- Fig. 1. Parafilaria bovicola sp. nov., anterior end of female, lateral view.
  - 2. Parafilaria bovicola sp. nov., anterior end of female, ventral view.
  - 3. Parafilaria bovicola sp. nov., posterior end of female, lateral view.
  - 4. Serratospiculum thoracis sp. nov., anterior end of male, ventral view.

#### PLATE 2

- Fig. 1. Diplotrixna pycnonoti sp. nov., anterior end of female, lateral view.
  - 2. Diplotriæna pycnonoti sp. nov., posterior end of male, ventral view.
  - 3. Hamatospiculum dicruri sp. nov., posterior end of male, ventral view.
  - Hamatospiculum leticiæ sp. nov., posterior end of male, ventral view.

#### PLATE 3. SERRATOSPICULUM THORACIS SP. NOV.

- Fig. 1. Anterior end of female, lateral view.
  - 2. Mouth and papillæ, anterior view.
  - 3. Posterior end of female, lateral view.
  - 4. Posterior end of male, ventral view.

## PLATE 4. HAMATOSPICULUM OTOMELARUM SP. NOV.

- Fig. 1. Anterior end of female, lateral view.
  - 2. Mouth and papillæ, anterior view.
  - 3. Posterior end of female, lateral view.
  - 4. Posterior end of male, ventral view.

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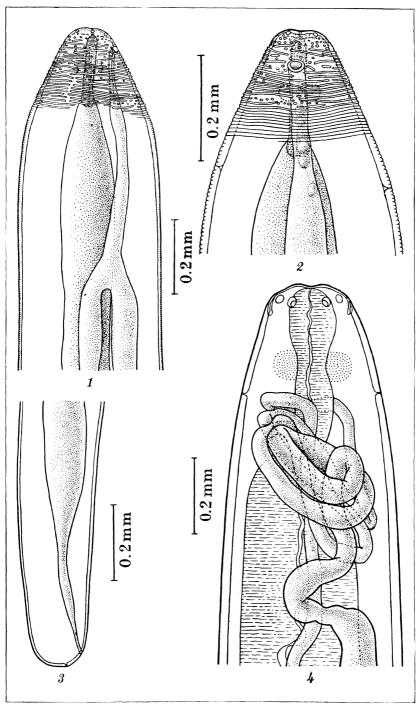


PLATE 1.

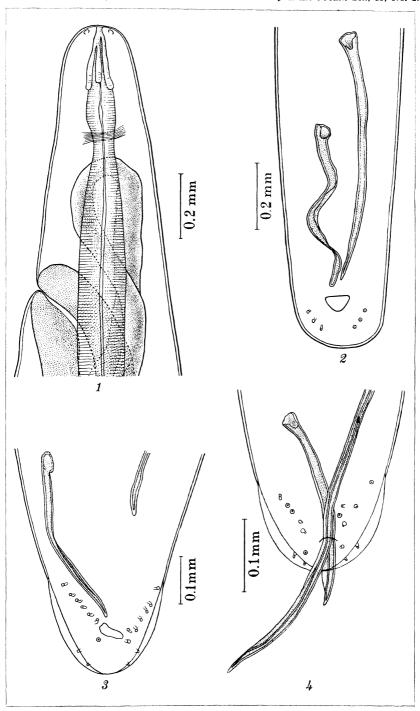


PLATE 2.

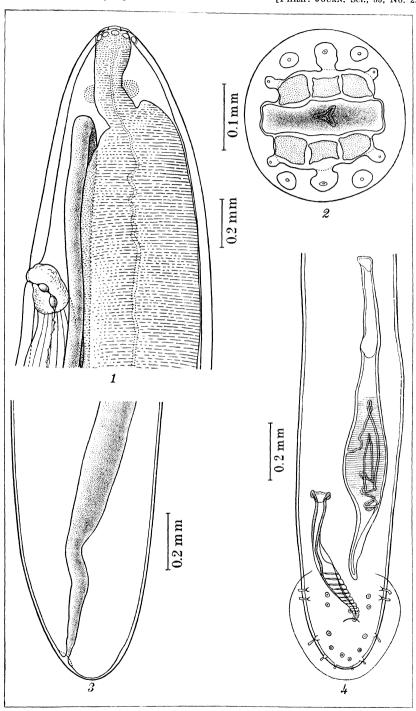


PLATE 3.



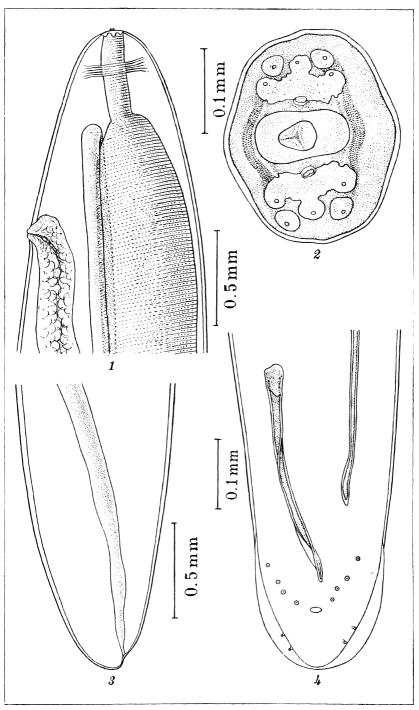


PLATE 4.



# HÆMORRHAGIC FILARIASIS IN CATTLE CAUSED BY A NEW SPECIES OF PARAFILARIA <sup>1</sup>

#### By ZACARIAS DE JESUS

Of the Veterinary Research Division, Bureau of Animal Industry, Manila
ONE PLATE AND ONE TEXT FIGURE

#### INTRODUCTION

An unusual case of parasitism in cattle characterized by profuse local hæmorrhages from slightly raised nodules was discovered by the writer July 2, 1932, in Tanauan, Batangas, Philippine Islands.

The subject was a native bull (*Bos taurus*), ashey red in color, eight years old, and belonging to Miss Victorina Macaisa and her sisters. The animal has been raised and is used for plowing in Barrio Kale of the municipality of Tanauan. The owners as well as the tenant using this animal observed this condition for the first time in 1931.

A survey of the barrio of Kale April 28, 1933, revealed that four other cattle of both sexes, from two to five years old, were affected. A carabao, male, six years old, show the same symptoms, but no worm was recovered from two lesions. None of the horses raised in the same barrio and coming in contact with the infested cattle showed any symptom of this disease.

Railliet and Moussu (1922) report the occurrence of hæmorrhagic filariasis in the donkey. They point out that the parasite is lodged in the intermuscular, interfascicular, and subcutaneous connective tissue. These writers cite the reports of Sibal of its occurrence in horses of Tartaric origin, of Spinola and Leblanc in Russian horses, and of Bernard and Liautard in mules in Algeria. Drouilly, Trasbot, Mégnin, von Ratz, and others, according to Neumann (1910) and Hutyra and Marek (1926), observe hæmorrhagic filariasis in horses of Hungarian, Russian, and Tartaric origin.

Drouilly (1877) (Cited by Railliet and Moussu, 1892) reports the cause of hæmorrhagic filariasis in equines as Filaria papillosa [= Parafilaria multipapillosa (Condamine and Drouilly,

<sup>&</sup>lt;sup>1</sup> Bureau of Animal Industry Technical Bulletin 6. Received for publication July 21, 1934.

1878)] (=Filaria haemorrhagica Railliet, 1885). Yorke and Maplestone (1926) and Baylis (1929) record only one species of Parafilaria from the horse tribe. According to Baylis (1929), Parafilaria multipapillosa is a parasite of the horse, donkey, and mule, and occurs chiefly in Oriental countries or in animals of Eastern origin. This writer states that it inhabits the subcutaneous and intermuscular connective tissue, and is the cause of a troublesome affection variously known as hæmorrhagic filariasis or parasitic dermatorrhagia.

There is no report, however, on the occurrence of this disease in cattle nor the collection of a species of *Parafilaria* from bovines. Hence, the present study here reported, which covered a period of two years, may be the first record of hæmorrhagic filariasis in cattle caused by another species of *Parafilaria*.

#### **ETIOLOGY**

The causal organism is a filaria belonging to the genus *Parafilaria* Yorke and Maplestone, 1926. The female has a whitish body measuring from 40 to 50 millimeters in length by 0.40 millimeter in maximum diameter. The eggs, which are very thinshelled and are already embryonated when laid, are 40 to 52 by 27 to 33.2 microns in size. Several specimens of this parasite were submitted to Dr. Marcos A. Tubangui of the Philippine Bureau of Science who describes them in a preceeding paper in this issue of the Philippine Journal of Science as *Parafilaria bovicola*.

The females of this *Parafilaria* were found lodged in the nodules (fig. 1, f). No male specimen was recovered from the lesions. The locations of the males as well as the other locations of the females have not been determined for there has been no opportunity to post an infested animal. For this reason the complete pathology of the disease has also not yet been determined.

The life history and transmission of this parasite is not yet known. The writer has an infested bull under observation in an attempt to determine the mode of transmission as well as the life history of the parasite.

#### SYMPTOMS

The infested animals at first showed slightly raised nodules scattered on the different parts of the body and neck. The nodules were irregular, and were from 5 to 7 millimeters thick and from 15 to 25 millimeters in diameter at the base. As a

rule these nodules were not painful on palpation. They were tough and the skin covering them was thickened. But the involved skin at this stage of the disease did not show any sign of inflammation. The first symptoms generally appeared about the beginning of December.

Two to three weeks later some nodules began to bleed profusely and became enlarged and slightly raised, attaining a maximum diameter of 40 millimeters at the base and a maximum thickness of 10 millimeters (Plate 1, figs. 1 and 2 marked b). On palpation the bleeding nodules were painful and were as tough as the nonbleeding ones (n). At the highest point of a bleeding nodule there was a fistulous tract or opening extending through the skin, measuring about 1 millimeter in diameter, from which the blood oozed out (fig. 1, e). In one case the blood was actually seen dripping slowly in a tiny stream from a nodule on the back down across the side to the belly. Incision through the skin along the fistulous tract showed that the tissues immediately around the tract were highly inflamed with a thin layer of necrotic tissues lining the tract.

The hæmorrhage was more profuse in animals that were used for plowing or pulling carts and in those that grazed in the open on hot days. The bleeding was recurrent. In exceptional cases, however, the hæmorrhage took place during the hotter part of the day and subsided at night, and then recurred every day for three to five days. If not attended to, the bleeding stopped by itself, the fistulous tract becoming plugged with some coagulated blood. The hæmorrhage per se did not seem to affect the patient. But sometimes as many as seven nodules were bleeding profusely at the same time in which case the infested animal showed general debility. It had a pale mucous membrane indicating anemia, lost in weight, and its pulling power was much reduced.

One infested animal, 8 years old, male, and used for plowing, was examined at long intervals for the occurrence and the distribution of the nodules. The symptoms were seasonal in their occurrence and variable in their duration as shown in Table 1. The distribution of the nodules was also variable. They were generally manifested by the infested animals during the period from the latter part of December to the middle part of July. Then all the nodules disappeared completely. At other times, the disease, in all its stages, persisted even up to the middle of September.

Date.	Non- bleeding nodules.	Bleeuing nodules.	Location.	
July 2, 1982	4	7	Neck, withers, shoulders, and back.	
July 16, 1932	7	3	Neck, withers, shoulders, back, and thigh.	
April 28, 1933	8	1	Neck and shoulders.	
May 15, 1933	4	5	Neck, shoulders, and back.	
September 7, 1933	3	0	Neck and shoulders.	
October 9, 1933	0	0		
November 13, 1933	0	0		
December 29, 1933	2	1	Neck and shoulders.	
February 27, 1934	3	2	Neck, shoulders, and back.	

TABLE 1.—Showing the occurrence and distribution of the nodules.

#### DIAGNOSIS

Hæmorrhagic filariasis in cattle was diagnosed by the presence of the characteristic symptoms and the recovery of the *Parafilaria* from the nodules. Incipient cases were difficult to diagnose due to the absence of profuse local hæmorrhages which were pathognomonic of the disease. It had been observed that the worms were not present in nonbleeding nodules. In advanced cases the characteristic local hæmorrhages from the

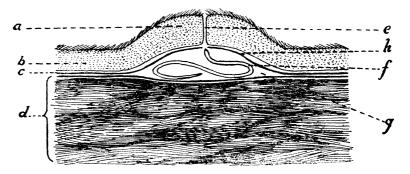


Fig. 1. A schematic drawing showing the cross section of a nodule with a Parafilaria in situ.

apices of the nodules were very prominent and the parasite could be recovered from the bleeding nodule.

This Parafilaria could be removed intra vitam from the nodules only by surgical means. For the sake of clarity the worm in situ is shown in a schematic drawing (fig. 1). By making an incision, 4 to 5 centimeters long, through the skin, a small fascicular fold (fig. 1, h) 2.5 centimeters in diameter, can be seen just beneath the skin. After cutting open the wall of the

Date.	Nonbleeding.		Bleeding.		77
	Number.	Positive.	Number.	Positive.	Worms in each nodule
July 2, 1932	1	0	2	1	One female.
July 16, 1932	0	0	2	2	Do.
April 28, 1933	8	0	1	0	None.
May 15, 1933	0	0	3	2	One female.
September 7, 1933	2	0	0	0	None.
December 29, 1933	1	0	2	1	One female.
February 27, 1934	0	0	1	1	Do.

TABLE 2.—Showing the results of the examinations of the nodules for Parafilaria.

sac or cyst, the worm (f) comes out with a little amount of seropurulent fluid. Only female worms were collected by this method. Just where the younger females as well as the males are lodged in the body of the host has not yet been determined.

The bleeding and nonbleeding nodules of some infested cattle were examined surgically for the presence of *Parafilaria*. The results are shown in Table 2. Deep skin scrapings from each of three bleeding and three nonbleeding nodules as well as the blood from the ear vein of each of three cattle were examined twice for *Microfilaria*. All the samples were negative. Several microscopic examinations of the blood oozing out from ten nodules were also negative. It is highly probable, however, that either the embryonated eggs or the larvæ may be found coming out of the nodules with the blood at a certain stage of the hæmorrhage. Hence, further investigation is being conducted to determine this point.

In the pre-bleeding stage of the disease the nodules may be confused with those of urticaria and insect bites. In the advanced stage the bleeding nodules may be mistaken for the lesions in skin myiasis. In myiasis, however, there is hardly any swelling of the affected parts, and on palpation the skin sinks and a sanguinous pus, which fills the cavity under the skin, oozes out. The opening is much larger and irregular in myiasis, and in most cases the maggots can be recovered from the cavities.

#### SUMMARY

1. Hæmorrhagic filariasis in cattle, which occurs in Tanauan, Batangas, Philippine Islands, and is characterized by profuse local hæmorrhages from slightly raised nodules, is hereby reported possibly for the first time.

- 2. This filariasis is caused by a new species of filaria (Para-filaria bovicola).
- 3. Only mature females were found in the bleeding nodules, and no specimens were found in the nonbleeding ones.
- 4. The occurrence of the disease is seasonal and its duration variable.
- 5. While the disease is benign, heavily infested animals, on account of general debility as a sequel, are predisposed to more dangerous microbian diseases.
- 6. This species of *Parafilaria* is apparently not transmissible to horses.
- 7. While no parasites were found in the bleeding nodules of a carabao presenting symptoms very similar to those manifested by infested cattle, there is reason to suppose that carabaos are susceptible to this parasitic disease.

## ACKNOWLEDGMENT

The writer is indebted to the College of Veterinary Science for the facilities afforded him in conducting this investigation while still in Los Baños. Thanks are due Dr. Teodulo Topacio, chief of the Veterinary Research Division, for his valuable suggestions, and Miss Victorina Macaisa and her sisters for kindly allowing the writer to conduct this investigation on their farm.

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# **ILLUSTRATIONS**

#### PLATE 1

- FIG. 1. A bull suffering from hæmorrhagic filariasis, showing nodules.
  - 2. A close-up of a portion of the body of the same animal showing bleeding (b) and nonbleeding (n) nodules.

(Photographed by the author. Enlarged by the Division of Publications, Department of Agriculture and Commerce.)

TEXT FIGURE 1. A schematic drawing showing the cross section of a nodule with a Parafilaria in situ.

- a. Indurated skin over the nodule.
- b. Normal skin.
- c. Fascia.
- d. Muscles.
- e. Fistulous tract.
- f. Parafilaria.
- g. Fascicular sac or cyst.
- h. Fold of fascia.



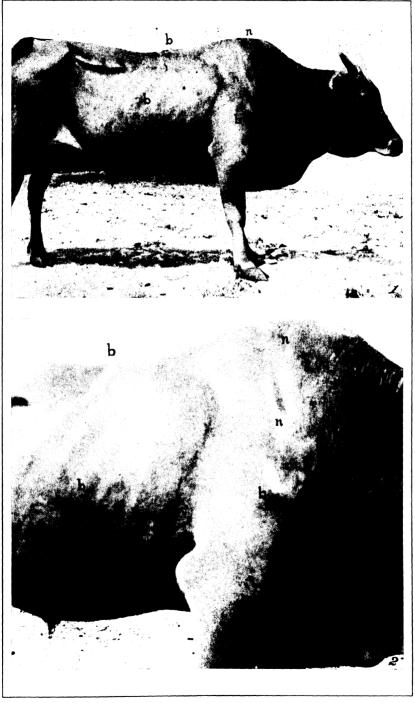


PLATE 1.

# NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXII <sup>1</sup>

By CHARLES P. ALEXANDER Of Amherst, Massachusetts

#### THREE PLATES

The crane flies discussed herewith are chiefly from Celebes Island, where they were collected by my friend and colleague Mr. Charles F. Clagg. A further considerable series of species are from Formosa where they were secured by Messrs. Esaki, Gressitt, and Issiki. One further species is from Korea where it was taken by Professor Masaki. The Esaki material has been returned to Professor Esaki for incorporation in the collection of the zoölogical laboratory, Kiushiu Imperial University; all other species are preserved in my own extensive series of these flies through the friendly interest of the various collectors.

#### TIPULINÆ

TIPULA (LUNATIPULA) MULTIBARBATA sp. nov. Plate 1, fig. 1; Plate 2, figs. 25, 26.

Belongs to the *marmoratipennis* group; antennæ weakly bicolorous, the bases of the flagellar segments narrowly pale; præscutal stripes four in number, gray, narrowly bordered by brown; femora yellow, the tips narrowly brownish black; wings creamy white, heavily marmorate with pale brown and darker brown clouds; male hypopygium with conspicuous brushes of long yellow setæ on the tergite and on the eighth sternite, the latter sclerite extensive but not extended far caudad into a boat-shaped structure, as is the case in certain other species of the group.

Male.—Length, about 15 millimeters; wing, 21.

Frontal prolongation of head brownish, the long strong nasus chiefly yellow; palpi yellow, the outer segments somewhat darker. Antennæ of moderate length, if bent backward extending to some distance beyond wing root; scape and pedicel yellow; flagellar segments dark brown, the extreme proximal ends of the basal enlargements yellow, to produce a weak bicolorous ap-

<sup>&</sup>lt;sup>1</sup> Contribution from the entomological laboratory, Massachusetts State College.

pearance; longest verticils subequal to the segments; last flagellar segment approximately one-half as long as the penultimate. Head light ashy gray, the center of vertex extensively cinnamon-brown, with a further dark brown, capillary, median vitta.

Mesonotal præscutum light gray, with four distinctly separated, darker gray stripes that are narrowly bordered by brown; scutal lobes gray, with darker gray central areas; posterior sclerites of notum gray, with a capillary brown median Pleura gray, the dorsopleural region rather light brown. Halteres yellow, the base of knob brown, the apex yellowish. Legs with the coxæ yellowish, sparsely pruinose; trochanters yellow; femora yellow, the tips narrowly brownish black, somewhat lighter on the flexor surface; tibiæ brownish yellow, the tips narrowly and rather weakly infuscated; tarsi passing into brownish black. Wings (Plate 1, fig. 1) with the ground color whitish cream, variegated with pale brown and darker brown, the general appearance being rather heavily marmorate; cell Sc uniform yellow, contrasting with the whitish cell C; post-arcular darkening in bases of cells R and M restricted; stigma brown, its central portion more yellow; the darkened clouds leave a narrow oblique band of the ground color extending from behind origin of Rs to the wing margin in cell 1st A; veins Macrotrichia of veins relatively small and weak, on R<sub>3</sub> restricted to two or three near outer end of vein; squama with about sixteen to eighteen strong black setæ. Venation: Free tip of  $Sc_2$  far before  $R_{1+2}$ , so cell  $Sc_2$  at costa is unusually extensive; Rs elongate, exceeding twice m-cu; vein R<sub>3</sub> rather strongly arcuated, slightly narrowing cell R<sub>3</sub> at near midlength; cell 1st M<sub>2</sub> relatively long, m being much longer than the basal section of  $M_{1+2}$ ; m-cu at fork of  $M_{3+4}$ .

Abdominal tergites one to five light grayish yellow, each with an interrupted brown median dash, the lateral borders of tergites one to two narrowly dark brown; lateral borders of tergites narrowly silvery gray, increasing in area on the outer segments; sixth and succeeding tergites passing into brownish black; sternites with basal five segments yellow, the outer ones darker. Male hypopygium (Plate 2, fig. 25) with the ninth tergite, 9t, fused with the sternite, 9s, on posterior half; basistyle and the small sternite entirely fused. Ninth tergite (Plate 2, fig. 25, 9t) narrow, constricted by pale membrane on cephalic portion; caudal margin with a median and two lateral lobes that are densely set with short blackened setæ; behind or ce-

phalad of these three cushions, on either side of midline, a transverse group of long conspicuous erect yellow setæ; viewed laterally, the median black cushion is seen to lie farther cephalad than the more-projecting lateral pair. Outer dististyle broad on basal half, the outer half more narrowed, the inner face set with small black spines, of which the outer two or three are larger and more conspicuous. Inner dististyle, id. about as shown, the outer angle a powerful black spine; viewed separately and in a flattened condition, the style appears conspicuously bilobed on inner margin, with a deep U-shaped emargination separating the lobes. Eighth sternite (Plate 2, fig. 26, 8s) very extensive, sheathing, the lateral edges extending high up over the sides of the ninth sternite, the outer lateral angles produced into pale bulbous lobes that are set with abundant long pale setæ; median area of sternite truncate, with a transverse row of long yellow setæ.

Habitat.—Korea.

Holotype, male, Shorei, July 9, 1923 (J. Masaki).

The marmoratipennis group includes, besides the typical form and the present fly, three Japanese species, holoteles Alexander, naviculifer Alexander, and shogun Alexander, that are among the most beautiful and conspicuous of all Japanese species of Tipula. The group is best distinguished by the short, fleshy valves of the ovipositor, and by certain venational details, as the unusually long Rs and the more or less arcuated vein R<sub>3</sub>, which tends to narrow cell R<sub>3</sub>. I have been privileged to study both the type and paratype of marmoratipennis Brunetti (holotype, female, Darjiling, altitude 7,000 feet, May, 1910—not "April" as stated by Brunetti—paratype, female, Darjiling, August 7, 1909), through the friendly interest of the authorities of the Indian Museum.

The present fly is very different from the other Japanese species listed above. The male hypopygium is quite distinct, notably the eighth sternite, which, while very extensive and sheathing, yet is not at all narrowed into a boat-shaped median lobe as in the other species (male sex not yet known in holoteles).

#### DOLICHOPEZA (NESOPEZA) TOALA sp. nov. Plate 1, fig. 2; Plate 2, fig. 27.

Belongs to the *costalis* group; mesonotal præscutum dark cinnamon-brown; pleura almost uniformly dark brown, only the ventral pteropleurite restrictedly paler; legs with the femora obscure yellow, the tips weakly darkened; tibiæ dirty brown; tarsi snowy white; wings with the ground color rather strongly

infumed; cell  $M_1$  subequal to or shorter than its petiole; male hypopygium with the median area of tergite produced into a low triangular point; eighth sternite with the median area slightly produced and provided with pale yellow setæ.

Male.—Length, about 8.5 to 9 millimeters; wing, 10 to 10.5. Female.—Length, about 11 millimeters; wing, 11.

Rostrum and palpi dark brown. Antennæ with the scape and pedicel light brown; first segment of flagellum obscure yellow, the outer segments dark brown; flagellar segments cylindrical, with short inconspicuous verticils. Head with the front and anterior vertex cinnamon-brown, the posterior vertex and occiput darker brown.

Mesonotal præscutum and scutum dark cinnamon-brown; scutellum and mediotergite a little darker brown. Pleura dark brown, only the ventral pteropleurite restrictedly paler. Halteres pale, the knobs dark brown. Legs with the fore and middle coxæ dark brown, the posterior coxæ more testaceous; trochanters yellow; femora obscure yellow, the tips weakly darkened; tibiæ dirty brown, the extreme base more whitened; tarsi snowy white (fore and hind legs broken). Wings (Plate 1, fig. 2) with the ground color rather strongly infumed; the usual dark costal pattern of the costalis group is present, the areas not margined by paler; cell R<sub>3</sub> with brown clouds on outer portion, including a band at two-thirds the length; cell Cu darkened; veins dark brown. Venation: Rs elongate and spurred, as in group; medial forks short, cell M<sub>1</sub> subequal to or shorter than its petiole; cell 2d A relatively wide.

Abdomen with basal segments chiefly obscure yellow, beyond the second chiefly dark brown, especially medially and at outer ends. Male hypopygium (Plate 2, fig. 27) with the median area of tergite, 9t, produced into a low triangular point. Eighth sternite, 8s, with the median area slightly produced and provided with pale yellow setæ, some of which are decussate at midline.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (*Clagg*). Allotopotype, female. Paratopotypes, 2 males.

The specific name is that of an aboriginal tribe of Celebes. The only allied species is *Dolichopeza* (Nesopeza) borneensis (Edwards), of North Borneo, which differs in the coloration of the wings and the uniformly pale thoracic pleura. This latter

species has Rs with a longer basal spur and lying closer to R<sub>1</sub> than is the case in the present fly.

DOLICHOPEZA (NESOPEZA) PROFUNDEMARGINATA sp. nov. Plate 1, fig. 3; Plate 2, fig. 28.

Belongs to the *costalis* group; most nearly allied to *geniculata*; basal segments of flagellum pale; pleura brown, the dorso-pleural region and pteropleurite whitish; male hypopygium with median area of tergite unequally trilobed, separated from the slender lateral arms by narrow incisions; eighth sternite long and sheathing, profoundly emarginate medially, each lateral lobe obtusely rounded.

Male.—Length, about 8 millimeters; wing, 9.2.

Female.—Length, about 10 millimeters; wing, 9.

Rostrum dark brown; palpi brown, especially the outer segment. Antennæ with scape dark brown, pedicel a trifle paler; flagellum with basal segments white, the outer ones passing into pale brown; flagellar segments cylindrical, with verticils that are shorter than the segments. Head pale brown.

Mesonotum brown, the præscutal stripes scarcely demarked. Pleura brown, the dorsopleural region and pteropleurite whitish. Halteres white, the knobs dark brown. Legs with the coxæ dark brown, the posterior pair paler on basal portions; trochanters pale yellow; femora pale yellow, the tips broadly and conspicuously black, preceded by a narrow, more whitish ring; tibiæ dirty white, the tips narrowly blackened, preceded by a clearer ring; tarsi snowy white. Wings (Plate 1, fig. 3) with the ground color grayish, with the usual dark brown pattern of the group, the costal areas narrowly bordered behind by whitish; isolated white spots in outer ends of cells R<sub>3</sub> and R<sub>5</sub>; small white spots at h and arculus; veins chiefly pale brown, the cord and elements lying in the dark markings brown. Venation: Basal spur of Rs elongate; forks of medial field short.

Abdominal tergites dark brown, the lateral portions of the second tergite restrictedly pale; succeeding tergites variegated beyond base with obscure yellow. Male hypopygium with the ninth tergite (Plate 2, fig. 28, 9t) having the median area protuberant, unequally trilobed, separated from the lateral portions by a notch; lateral arms relatively slender, with several small wartlike points. Eighth sternite, 8s, large and sheathing, profoundly emarginate medially, forming two short cylindrical lobes with blunt tips; at base of notch, on either side, with a small lobule; median region of sternite cephalad of base of emargination with pale membrane almost to border of sclerite.

Habitat.—Formosa (north).

Holotype, male, Urai, altitude about 1,500 feet, April 1, 1932 (*Gressitt*). Allotype, female, Giran, November 20, 1928 (*Issiki*).

Dolichopeza (Nesopeza) profundemarginata is very similar to D. (N.) geniculata Alexander (Japan) in all colorational features, differing notably in the structure of the male hypopygium, especially the long, sheathing sternite that is deeply emarginate.

DOLICHOPEZA (NESOPEZA) TORAJA sp. nov. Plate 1, fig. 4; Plate 2, fig. 29.

Belongs to the *gracilis* group; wings tinged with brown, the usual darkened pattern of the group very poorly defined and not extending distad beyond the stigma; male hypopygium with median region of tergite only slightly convex; eighth sternite unarmed.

Male.—Length, about 8 millimeters; wing, 8.8.

Rostrum and palpi dark brown. Antennæ with scape dark brown, the succeeding segments paler brown; flagellar segments long-cylindrical, clothed with a short dense white pubescence and with short inconspicuous verticils. Head dark brown.

Mesonotal præscutum brown, with three brownish black stripes, the median one elongate, the laterals abbreviated; scutal lobes variegated with dark brown; scutellum brownish black; mediotergite brown. Pleura distorted in the unique type, apparently almost uniform brown. Halteres elongate, black, the base of stem restrictedly pale. Legs with the coxæ brownish; trochanters paler; remainder of legs broken. Wings (Plate 1, fig. 4) with the ground color weakly tinged with brown; the usual dark costal pattern of the group is here only faintly differentiated from the ground color, being indicated by a darkening at base, the costal region and the stigma, with further very restricted clouds at origin of Rs, anterior cord, and end of vein Cu<sub>1</sub>; no darkening beyond stigma; veins dark brown. Venation: Rs elongate, angulated and long-spurred near origin; medial forks relatively deep.

Abdominal tergites weakly bicolorous, the basal half or more brownish yellow; posterior ring dark brown or brownish black. Male hypopygium (Plate 2, fig. 29) with the median region of tergite, 9t, almost transverse or only feebly elevated, narrowly blackened; lateral lobes of tergite obtuse. Inner dististyle, id, with the apical beak slender. Eighth sternite, 8s, with the caudal margin very gently convex, without special armature of lobes or setæ.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (Clagg).

The specific name is that of an aboriginal tribe inhabiting central, southeastern, and eastern Celebes. *Dolichopeza* (Nesopeza) toraja is very distinct from all other members of the gracilis group in the slightly infumed wings and scarcely differentiated dark costal pattern.

# LIMONIINÆ LIMONIINI

LIMONIA (LIBNOTES) FALSA sp. nov. Plate 1, fig. 5; Plate 2, fig. 30.

Mesonotal præscutum shiny reddish, the posterior sclerites of mesonotum and the pleura variegated with dark brown or brownish black; antennæ black throughout, the flagellar segments with long verticils; halteres yellow, knobs brownish black; wings whitish subhyaline, prearcular region yellow; costal border of wings dark brown; free tip of  $Sc_2$  lying far before level of  $R_2$ ; m-cu opposite midlength of cell 1st  $M_2$ ; anal veins convergent; abdominal tergites brownish black medially, pale laterally; male hypopygium with the rostral prolongation long and slender, with two small spines at base.

Male.—Length, about 7 millimeters; wing, 8.

Rostrum and palpi black. Antennæ black throughout; flagellar segments long-oval, with elongate verticils that considerably exceed the segments. Head dark gray, the front and very narrow anterior vertex silvery.

Pronotum dark brown above, more yellowish on sides. Mesonotal præscutum shiny red, unmarked; scutum dark brown, the centers of the lobes more castaneous; scutellum testaceousbrown; mediotergite dark brown. Pleura with the propleura and ventral sternopleurite more yellowish; dorsal sternopleurite, anepisternum, and posterior pleural sclerites darker brown. Halteres yellow, the knobs brownish black. Legs with the coxæ and trochanters yellow; femora yellow basally, at near midlength becoming darker, at tips passing into brownish black; tibiæ brownish yellow, the tips narrowly darker; tarsi brownish yellow, the outer segments darker. Wings (Plate 1, fig. 5) whitish subhyaline; prearcular region light yellow; costal border, including cells C and Sc, dark brown, the color continued outward to wing tip; stigma very small, still darker brown; brown seams along vein Cu, on m-cu and in axillary region; veins dark brown,

luteous in the prearcular field. Macrotrichia of veins long and conspicuous. Venation:  $Sc_2$  ending about opposite midlength of cell 1st  $M_2$ ,  $Sc_2$  longer than  $Sc_1$ ; Rs elongate; free tip of  $Sc_2$  far before level of  $R_2$ ;  $R_1$  with numerous trichia;  $R_{1+2}$  jutting beyond  $R_1$  as a slight spur or thickening; outer radial veins moderately decurved at tips; m-cu at midlength of cell 1st  $M_2$ ; vein 2d A converging strongly toward 1st A.

Abdominal tergites yellow, brownish black medially, forming a continuous median stripe that is a little expanded at the posterior borders of the segments; sternites yellow, segments eight and nine brownish black, the styli pale. Male hypopygium (Plate 2, fig. 30) with the tergite, 9t, broadly transverse, the caudal border convex. Ventral dististyle, vd, smaller in area than the basistyle; rostral prolongation long and slender, with two rostral spines close to its base; a pale lobe on face of style opposite base of prolongation (not shown in figure). Mesalapical lobe of gonapophysis slender. Ædeagus, a, very broad.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (Clagg).

Despite its small size and the unusual pattern of the wings, the present fly belongs to the typical section of the subgenus, having convergent anal veins and a hypopygium of the general structure of this group of species. In Edwards's key to the species of  $Libnotes^2$  the fly runs to couplet 28, disagreeing with all species beyond by the wing pattern and venation of the radial field, especially the position of the free tip of  $Sc_2$  some distance proximad of  $R_2$ .

## LIMONIA (LIBNOTES) COMISSABUNDA sp. nov. Plate 1, fig. 6.

General coloration of mesonotum buffy, the præscutum vaguely lined with darker; antennæ black; femora yellow, with a brown subterminal ring; wings whitish subhyaline, with a restricted brown pattern, including seams along cord and outer end of cell 1st  $M_2$ ; vein  $R_{2+3}$  strongly arcuated at proximal end; cell 1st  $M_2$  elongate, widened at outer end, m-cu at near one-third its length; m gently arcuated, about twice the basal section of  $M_3$ ; anal veins convergent at bases; ovipositor with cerci bidentate at tips.

Female.—Length, about 10 millimeters; wing, 12.

Rostrum and palpi brownish black. Antennæ brownish black; flagellar segments oval, the longest verticils about twice the seg-

<sup>&</sup>lt;sup>1</sup> Journ. Fed. Malay St. Mus. 14 (1928) 74-80.

ments. Front and anterior vertex light golden yellow; posterior vertex grayish brown, the central portion more fulvous, with a further capillary dark line.

Pronotum buffy on sides and as a mid-dorsal vitta, the remainder of dorsum dark brown. Mesonotum buffy, vaguely lined with darker, including a pair of intermediate brown stripes; posterior sclerites of notum sparsely pruinose, the centers of the scutal lobes darker. Pleura pale, the propleura and ventral anepisternum weakly darkened. Halteres elongate, yellow, the knobs dark brown basally, the apices a little brightened. with the fore coxæ a trifle darker than the others, middle and posterior coxæ yellow; trochanters yellow; femora yellow with a brown subterminal ring at about its own width before the tip; tibiæ light brown, the tips narrowly darkened, the outer tarsal segments darkened. Wings (Plate 1, fig. 6) whitish subhyaline, the prearcular and costal regions more yellow; a restricted brown pattern, appearing as seams to certain of the veins, including the cord and outer end of cell 1st  $M_2$ ; basal half of  $R_{2+3}$ and adjoining portions of outer end of vein Sc; narrow stigmal area; outer third of 2d A; less distinct clouds at arculus and in axillary region; veins yellow, dark brown in the clouded areas. Venation: Sc long, Sc<sub>1</sub> ending beyond m-cu, Sc<sub>2</sub> at its tip; Rs gently arcuated;  $R_{2+3}$  strongly arcuated at proximal end, constricting cell R<sub>1</sub> at near one-third the length; R<sub>3</sub> decurved at outer end; free tip of Sc<sub>2</sub> and R<sub>2</sub> in approximate transverse alignment; cell 1st M<sub>2</sub> elongate, widened at outer end; m gently arcuated, about twice the basal section of M<sub>3</sub>; m-cu at just before one-third the length of cell 1st M<sub>2</sub>; anal veins convergent at bases.

Abdominal tergites variegated with dark brown and obscure yellow, the ground color dark, the caudal borders more yellow; sternites with the pattern similar but less contrasted. Ovipositor with the cerci bidentate at tips.

Habitat.—Formosa (north).

Holotype, female, Taiheizan, May 6, 1932 (Gressit).

In Edwards's key to the species of Libnotes  $^3$  the present fly runs to Limonia (Libnotes) nohirai (Alexander), which differs notably in the broadly blackened tips of the femora and in the details of venation. In its general appearance the species also suggests species such as L. (L.) amatrix (Alexander), but differs

conspicuously in the pattern of the legs and wings, and in the venation.

LIMONIA (LIMONIA) ALOPECURA sp. nov. Plate 1, fig. 7; Plate 2, fig. 31.

Belongs to the *pendleburyi* group; coloration almost uniformly pale testaceous-brown to reddish brown; antennæ relatively long; wings whitish subhyaline, the stigma conspicuous, dark brown; cell 1st M<sub>2</sub> large, exceeding the veins beyond it; male hypopygium unusually complex in structure, the basistyle bearing three distinct lobes and outgrowths on mesal face.

Male.—Length, about 5 millimeters; wing, 6.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi brown. Antennæ relatively long; scape and pedicel dark brown, flagellum paler, testaceous-brown; flagellum moniliform, the segments strongly constricted at outer ends into short pedicels; terminal segment longer than the penultimate, strongly pointed at outer end; flagellar segments with abundant pale setæ. Head dark gray.

Mesonotum and pleura almost uniformly pale testaceous-brown to reddish brown. Halteres pale, the knobs weakly darkened. Legs with the coxæ and trochanters testaceous-yellow; femora whitish, the tips narrowly darkened; tibiæ and basitarsi dirty white, the tips narrowly darkened; outer tarsal segments darkened. Wings (Plate 1, fig. 7) whitish subhyaline, the oval stigma conspicuous, dark brown; veins yellow, beyond the cord more brownish yellow. Venation:  $Sc_1$  ending shortly beyond midlength of Rs,  $Sc_2$  at its tip; free tip of  $Sc_2$  and  $R_2$  in approximate transverse alignment, or the latter a little more basad; cell 1st  $M_2$  large, exceeding the veins beyond it; m-cu shortly beyond fork of M, subequal to the distal section of  $Cu_1$ .

Abdominal tergites brown, the sternites yellow. Male hypopygium (Plate 2, fig. 31) with the caudal border of the long tergite, 9t, convexly rounded. Basistyle, b, with the mesal armature consisting of three complex lobes; namely, first, a short flattened blade that terminates in a comblike series of acute spines; second, a dusky blade, the base narrow, the apex expanded, obliquely truncate, with long coarse setæ; third, a slender-based spatulate lobe, the dilated head with recurved delicate setæ. Dististyle, d, complicated by lobes and outgrowths, the most conspicuous element being a broadly flattened spatula that is densely clothed with long setæ. Gonapophyses, g, with the outer margin corrugated as in group.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 4,500 to 6,000 feet, May 25, 1931 (*Clagg*.) Allotype, female, altitude 5,800 feet, May 24, 1931 (*Clagg*).

Limonia (Limonia) alopecura resembles other species of the pendleburyi group in its general appearance but is very different in the unusually complicated male hypopygium, especially the basistyle.

## LIMONIA (LIMONIA) INSCITA sp. nov. Plate 1, fig. 8; Plate 2, fig. 32.

General coloration of mesonotum brownish yellow to testaceous-yellow; knobs of halteres dark brown; wings with a faint brown tinge; stigma oval, a trifle darker than the ground;  $Sc_1$  ending about opposite two-fifths the length of Rs,  $Sc_2$  at its tip; Rs angulated and weakly spurred at origin; male hypopygium with the dorsal dististyle microscopically setulose; ventral dististyle relatively small, the rostral prolongation with two spines, the innermost from an enlarged basal tubercle.

Male.—Length, about 4 millimeters; wing, 4.8.

Rostrum obscure yellow; palpi brownish black. Antennæ with the basal segments damaged; flagellum black; flagellar segments oval. Head dark gray.

Pronotum yellowish testaceous, with long erect black setæ. Mesonotum gibbous, brownish yellow to brownish testaceous. Pleura testaceous-yellow. Halteres with the stem pale, the base yellow, the knob dark brown. Legs with the coxæ and trochanters yellow; femora testaceous-brown, the outer segments of the tarsi slightly darker. Wings (Plate 1, fig. 8) with a very faint brown tinge; stigma oval, a trifle darker brown; veins brown. Venation: Sc of moderate length,  $Sc_1$  ending about opposite two-fifths the length of Rs,  $Sc_2$  at its tip; Rs angulated and weakly spurred at origin; free tip of  $Sc_2$  and  $R_2$  in alignment; m-cu oblique, just before the fork of M, subequal to the distal section of Cu; anal veins parallel at origin.

Abdomen dark brown; hypopygium pale. Male hypopygium (Plate 2, fig. 32) with the caudal margin of the tergite, 9t, strongly notched medially. Basistyle, b, relatively small, the mesal lobe large. Dorsal dististyle, dd, with the surface on basal two-thirds with microscopic setulæ. Ventral dististyle, vd, subequal in area to the basistyle; prolongation with two strong spines of equal length, placed close together on basal third of prolongation; inner spine from a more strongly de-

veloped tubercle than the outer spine. Gonapophyses, g, with the mesal-apical lobe curved, blackened.

Habitat.—Formosa (north).

Holotype, male, Urai, altitude about 1,500 feet, May 1, 1932 (*Gressitt*).

Limonia (Limonia) inscita is very different from other known species of the subgenus, as now known from the Japanese Empire. The type of hypopygium is somewhat as in L. (L.) fusca (Meigen), which is otherwise very different in the apically pubescent wings.

## LIMONIA (EUGLOCHINA) CURTATA sp. nov. Plate 1, fig. 9.

General coloration of mesonotum shiny brown, the pleura more yellow; wings whitish subhyaline, the cells beyond cord weakly darkened; stigma oval, dark brown; Sc very short, the distance between arculus and tip of  $Sc_1$  being shorter than the distance on R between  $Sc_2$  and origin of Rs; Rs short, oblique;  $R_1$  beyond Rs without further union with  $R_{2+3}$ ; cell  $M_2$  open by the atrophy of the basal section of  $M_3$ ; m-cu nearly its own length beyond fork of M; vein 2d A ending distinctly beyond level of vein Sc.

Female.—Length, about 5.5 millimeters; wing, 5.8.

Rostrum and palpi brownish black. Antennæ with scape and pedicel brownish black; flagellum dark brown; antennæ relatively elongate; flagellar segments fusiform. Head brown.

Mesonotum almost uniform shiny brown, the pleura more yellowish. Halteres elongate, the stem brown, the knob brownish black. Legs with the coxæ yellow; trochanters testaceous; remainder of legs broken. Wings (Plate 1, fig. 9) whitish subhyaline, the cells beyond cord, together with the apical border, a trifle darker; stigma oval, dark brown; veins dark brown. Macrotrichia of veins long and conspicuous. Venation: Sc very short, the vein between arculus and its tip shorter than the distance on R between  $Sc_2$  and origin of Rs; Rs very short, oblique, subequal in length to r-m, and with vein  $R_1$  beyond it simple, without connection with  $R_{2+3}$ ; basal section of  $R_{4+5}$  long and strongly arcuated; cell  $M_2$  open by atrophy of basal section of vein  $M_3$ ; m-cu nearly its own length beyond fork of M; vein 2d A ending distinctly beyond the level of end of vein Sc.

Abdomen with the segments brown, the basal portion a little brightened.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, female, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (Clagg).

Limonia (Euglochina) curtata is very different from the other described species of Euglochina in the whitish subhyaline wings, the very short Sc, short Rs, entire atrophy of vein  $R_2$ , and the open cell  $M_2$ . All other described species of the subgenus have Sc longer, always exceeding the distance between  $Sc_2$  and origin of Rs; Rs much longer than r-m;  $R_2$  present, connecting  $R_{1+2}$  with  $R_3$ ; and with cell 1st  $M_2$  closed.

HELIUS (HELIUS) COPIOSUS sp. nov. Plate 1, fig. 10; Plate 2, fig. 33.

General coloration of mesonotum dark brown; antennæ relatively long, dark brown throughout; flagellar segments cylindrical, with abundant, dense, erect setæ that are almost as long as the short verticils; wings pale yellowish subhyaline; stigma long-oval, pale brown; Sc<sub>1</sub> ending opposite fork of Rs; cell 1st M<sub>2</sub> short-hexagonal, with m-cu at midlength.

Male.—Length, including rostrum, about 6.5 millimeters; wing, 7.

Rostrum relatively long and slender, a little longer than the remainder of head, dark brown; palpi black. Antennæ relatively elongate, dark brown throughout; flagellar segments cylindrical, with abundant dense erect setæ that are almost as long as the short verticils. Head blackish, sparsely pruinose.

Mesonotum chiefly dark brown, the scutellum more testaceous. Pleura more reddish brown. Halteres yellow, the knobs weakly darkened. Legs with the fore coxæ darkened, the remaining coxæ and all trochanters yellow; femora and tibiæ pale brown, the tarsi passing into light yellow. Wings (Plate 1, fig. 10) pale yellowish subhyaline, the prearcular and costal regions a little brighter; stigma long-oval, pale brown; veins pale brown, more yellowish in the costal region. Anterior branch of Rs with relatively few macrotrichia, including about six or seven, widely scattered; other outer radial and medial veins with close, dense series of trichia; costal fringe of moderate length and very dense. Venation: Sc<sub>1</sub> terminating opposite fork of Rs; cell R<sub>2</sub> at margin narrow, subequal to m-cu; cell 1st M<sub>2</sub> shorthexagonal; veins issuing from cell 1st M<sub>2</sub> elongate; m-cu at midlength of the cell.

Abdomen dark brown; hypopygium yellow. Male hypopygium (Plate 2, fig. 33) with the basistyle, b, produced into a lobe on base of mesal face. Outer dististyle, od, short, blackened,

gently arcuated, the tip very weakly bidentate. What are presumably interbases, i, have the peculiar conformation shown in the figure. Ædeagus, a, weakly spiraliform at tip.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (Clagg).

By Edwards's synopsis of the Oriental species of *Helius* the present fly runs to *Helius* (*Helius*) kambangani (de Meijere) and H. (H.) fasciventris Edwards, but differs from both in the body coloration and venation. In the two latter species, Sc is unusually long, extending almost to opposite the outer end of cell 1st  $M_2$ , which latter is of peculiar shape, with m oblique in position and longer than the basal section of  $M_3$ .

## ORIMARGA (ORIMARGA) GYMNONEURA sp. nov. Plate 1, fig. 11; Plate 2, fig. 34.

General coloration dark gray; legs and antennæ black; wings grayish, very broad; wing veins unusually glabrous, there being no trichia on Rs or any of its branches;  $R_{2+3}$  about twice as long as  $R_2$ , the latter longer than  $R_{1+2}$ ; male hypopygium with the outer dististyle broader and less acutely pointed than usual in the genus; inner dististyle near apex bent almost at a right angle into a slender lobe; gonapophyses and interbases appearing as slender acute spines.

Male.—Length, about 5 millimeters; wing, 5 by 1.6.

Rostrum brown; palpi black. Antennæ black throughout; flagellar segments oval. Head gray.

Mesonotum almost uniformly dark gray, the posterior sclerites more dusted with lighter gray. Pleura dark gray; dorsopleural region dark. Halteres pale, the knobs slightly dusky. Legs with the coxæ reddish, sparsely pruinose; trochanters brownish testaceous; remainder of legs brownish black. Wings (Plate 1, fig. 11) grayish, the prearcular and costal regions a trifle brighter; veins dark brown. Wings very broad, as shown by the measurements; macrotrichia of veins unusually sparse, there being none on any of the veins beyond level of fork of Rs, excepting two or three near outer ends of each of veins  $M_{1+2}$  and  $M_3$ ; none on Rs or its branches. Venation:  $Sc_1$  ending shortly before fork of Rs,  $Sc_2$  at its tip;  $R_{2+3}$  about twice  $R_2$ , the latter longer than  $R_{1+2}$ ; r-m lying slightly beyond level of  $R_2$ ; m-cu opposite midlength of Rs; cell 2d A long-extended, its outer end opposite or shortly beyond m-cu.

<sup>&#</sup>x27;Journ. Fed. Malay St. Mus. 14 (1928) 85-86.

Abdomen dark reddish brown, the sternites a little brighter; hypopygium a little brighter. Male hypopygium (Plate 2, fig. 34) with the outer dististyle, od, much broader and less acutely pointed than is usual in the genus; inner dististyle, id, near apex bent almost at a right angle into a slender lobe. Gonapophyses, g, and interbases, i, appearing as slender acute spines, the tips narrowly pale.

Habitat.—Formosa (south).

Holotype, male, Keinensan, altitude 5,400 feet, August 14, 1933 (Issiki).

The unusually glabrous veins and the very broad wings will readily separate the present fly from all other species of *Orimarga* in eastern Asia.

# ORIMARGA (ORIMARGA) GRISEIPENNIS sp. nov. Plate 1, fig. 12.

General coloration of notum dark brown, grayish pruinose; rostrum obscure yellow; antennæ black throughout; legs black; wings grayish; macrotrichia on veins beyond cord relatively numerous;  $R_{2+8}$  fully one-half longer than  $R_2$ ; petiole of cell  $M_3$  relatively long, exceeding vein  $M_4$ ; basal portion of vein  $M_3$  distinctly preserved; m-cu nearly opposite midlength of Rs; abdomen reddish brown.

Female.—Length, about 5 millimeters; wing, 4.4.

Rostrum obscure yellow; palpi black. Antennæ black throughout; flagellar segments oval; verticils inconspicuous. Head dark gray.

Mesonotal præscutum and scutum dark brown, sparsely pruinose; scutellum reddish, very sparsely pruinose; mediotergite light gray. Pleura almost uniformly reddish yellow. pale, the base of stem yellow, the knobs weakly dusky. with the coxæ reddish; trochanters more testaceous; remainder of legs black, the femoral bases restrictedly or scarcely bright-Wings (Plate 1, fig. 12) grayish, the prearcular and costal regions more yellowish white; veins brown, slightly seamed with brown to produce a slight streaked appearance. Macrotrichia of veins beyond cord relatively abundant, there being close series on all of R<sub>3</sub> except the basal fourth; all of outer section of R<sub>4+5</sub>, and on basal section of the latter except for the slightly deflected basal portion; on outer section of  $M_{1+2}$ except the basal fifth; on entire lengths of veins M3 and M4. Venation: Sc1 ending beyond midlength of Rs, Sc2 at its tip; no trace of the free tip of Sc<sub>2</sub>; R<sub>2+8</sub> about one-half longer than R., the latter a little shorter than  $R_{1+2}$ ; petiole of cell  $M_3$  long,

exceeding vein  $M_4$  in length; base of vein  $M_3$  distinctly preserved; m-cu with its cephalic end nearly opposite mid-length of Rs.

Abdomen reddish brown throughout.

Habitat.—Formosa (south).

Holotype, female, Tyusinron, altitude 3,200 feet, August 18, 1933 (Issiki).

The nearest ally seems to be Orimarga (Orimarga) taiwanensis Alexander, which differs most evidently in the more brownish yellow wings, with the venational detail different, especially the position of m-cu and the short petiole of cell  $M_s$ .

ORIMARGA (ORIMARGA) TOALA sp. nov. Plate 1, fig. 13.

General coloration of thorax dark plumbeous gray; rostrum, palpi, and antennæ black; wings tinged with gray; macrotrichia of veins very sparse, quite lacking on veins  $R_{1+2}$ ,  $R_2$ ,  $R_{2+3}$ , and  $R_3$ ;  $R_{1+2}$  very short, not exceeding one-half  $R_2$ ; r-m and basal section of  $M_{1+2}$  in transverse alignment; cell  $M_3$  about one-half longer than its petiole; abdomen brownish black.

Female.—Length, about 4.5 millimeters; wing, 4.5. Rostrum black, paler ventrally; palpi black. Antennæ black throughout; flagellar segments suboval, with dense pubescence. Head plumbeous gray.

Mesonotum uniformly dark plumbeous gray. Pleura gray, the ventral pleurites a little more reddish. Halteres pale, the knobs weakly dusky. Legs with the fore coxe dark gray, the remaining coxæ testaceous gray; trochanters testaceous yellow; remainder of legs more yellowish brown, especially the tarsi. Wings (Plate 1, fig. 13) tinged with grayish; veins pale brown. Macrotrichia of veins very sparse, there being none on Rs,  $R_{1+2}$ ,  $R_2$ ,  $R_{2+3}$ , or  $R_3$ ; on  $R_{4+5}$ , with a series of about fifteen on distal half of outer section; a restricted series on outer ends of veins  $M_{1+2}$  and  $M_3$ . Venation: Sc, ends about opposite fivesixths the length of Rs, Sc<sub>2</sub> a short distance from its tip; R<sub>1+2</sub> very short, not exceeding one-half  $R_2$ ; basal section of  $R_{4+5}$ strongly angulated on basal third; r-m and basal section of  $M_{1+2}$  in transverse alignment; cell  $M_3$  about one-half longer than its petiole; m-cu opposite the basal third of Rs.

Abdomen brownish black, the sternites a trifle paler.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, female, Latimodjong Mountains, altitude 3,800 feet, May 15, 1931 (*Clagg*). Paratopotype, female.

Orimarga (Orimarga) toala is named after a tribe of aborigines inhabiting Celebes. Its nearest ally appears to be O. (O.)

borneensis Brunetti, with which it agrees in the general appearance and venation, as the very short  $R_{1+2}$ . The latter species is well-distinguished from toala by details of venation, as the elongate Rs and the arcuated basal section of  $M_{1+2}$ , which is much longer than r-m and not in alignment with it; and by the more abundant and conspicuous macrotrichia of the radial veins, including a series of about fifteen distributed over almost the whole length of vein  $R_3$ .

ORIMARGA (ORIMARGA) HYPOPYGIALIS sp. nov. Plate 1, fig. 14; Plate 2, fig. 35.

General coloration brownish gray, the præscutum more blackened medially; wings with a faint brown tinge; macrotrichia of outer radial and medial veins dense and abundant; Rs short and angulated at origin; R<sub>1+2</sub> long, approximately three times R<sub>2</sub> and nearly as long as R<sub>2+3</sub>; cell M<sub>3</sub> deep; male hypopygium with the tergite conspicuous, deeply emarginate, the lobes broadly rounded and without specially modified setæ; lobe of basistyle tapering to a narrow point, with numerous fasciculate setæ.

Male.—Length, about 5 millimeters; wing, 6.

Rostrum and palpi black. Antennæ black throughout. Head dark gray, the anterior vertex somewhat brighter.

Mesonotal præscutum brownish gray, the median stripe blackish, somewhat polished; lateral stripes poorly indicated; posterior sclerites of notum gray. Pleura blackish, sparsely pruinose. Halteres pale. Legs with the coxæ brownish black, the fore coxæ somewhat darker; trochanters brownish black; remainder of legs dark brown or brownish black. Wings (Plate 1, fig. 14) with a faint brown tinge; veins brown. Macrotrichia of veins relatively abundant, including a series of about twelve on  $R_{1+2}$  and more than fifty on  $R_3$  alone; complete dense series of trichia on all outer branches of R and R. Venation: Rs short and angulated near origin;  $R_{1+2}$  long, approximately three times  $R_2$  and nearly as long as  $R_{2+3}$ ; cell  $M_3$  deep,  $M_{3+4}$  being about two-thirds  $M_4$ ; m-cu just beyond the level of the bend of  $R_3$ .

Abdomen, including hypopygium, dark brown. Male hypopygium (Plate 2, fig. 35) of the general type of quadrilobata, differing especially in the broad lobes of the tergite, 9t, which are evenly rounded and without a group of specially modified setæ on their internal margin, and in the narrow lobe of the basistyle, b. Both species have the dististyles of approximately

the same conformation and with the abundant setæ of the lobe of the basistyle strongly fasciculate.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (Clagg).

The closest ally of the present fly is undoubtedly Orimarga (Orimarga) quadrilobata Alexander (Mindanao), which differs in the venation, especially the short  $R_{1+2}$ , and in the details of the structure of the male hypopygium, as the conformation of the tergite and lobe of the basistyle. Orimarga (O.) fryeri Edwards (Seychelles Islands) and O. (O.) flaviventris Edwards (Key Islands) likewise have hair brushes on the basistyle of the hypopygium but are otherwise very different flies.

#### HEXATOMINI

# EPIPHRAGMA (POLYPHRAGMA) MINAHASSANA sp. nov. Plate 1, fig. 15; Plate 3, fig. 36.

Belongs to the *ochrinota* group; mesonotum reddish brown, the surface very sparsely pruinose; pleura brownish black; darkened femoral ring pale brown; wings with a brown pattern that is narrowly bordered by yellow; male hypopygium with the interbase a simple rod, on outer fifth angularly bent to an acute point.

Male.—Length, about 7.5 millimeters; wing, 8.3.

Female.—Length, about 6.5 to 7 millimeters; wing, 6 to 6.5.

Rostrum and palpi brownish black. Antennæ with the scape brown, sparsely pruinose; pedicel and first two flagellar segments light orange-yellow; outer flagellar segments brown. Front and anterior vertex ashy gray; posterior vertex dark brown on central area, the lateral and orbital portions more fulvous.

Mesonotal præscutum and scutum reddish brown, the surface very sparsely pruinose; scutellum and mediotergite dark brown, sparsely pruinose. Pleura brownish black, immaculate, contrasting abruptly with the pale notum. Halteres with the stem yellow, narrowly darkened at extreme base, the knob infuscated. Legs with the fore and middle coxæ brownish yellow; posterior coxæ blackened; trochanters yellow; femora yellow, darkened to a pale brown subterminal ring, the tip again light yellow; tibiæ and tarsi yellow. Wings (Plate 1, fig. 15) with the ground color pale brown, variegated by darker brown spots and broken crossbands that are narrowly bordered by pale yellow; prearcular and costal regions yellow; cell C with about ten dark areas, some of which inclose spurs of crossveins; longitudinal veins at margin with brown spots, the ends of the correspond-

ing cells with yellow areas, more intense in the radial field; veins brown, more luteous in the costal field. Venation:  $R_{2+3+4}$  shorter than m-cu, the latter about one-half its length beyond the fork of M.

Abdomen dark brown, in male with intermediate portions of the sternites a little more yellowish. Male hypopygium (Plate 3, fig. 36) with the lobes of the tergite, 9t, slender, separated by a U-shaped notch. Dististyles, id, od, relatively small. Interbase, i, a long, powerful, simple rod, on outer fifth bent at an angle to the acute point.

Habitat.—North Celebes (Minahassa).

Holotype, male, Roeroekan, altitude 4,000 feet, April 18, 1931 (*Clagg*). Allotopotype, female. Paratopotype, female.

In my key to the species of *Polyphragma* <sup>5</sup> the present fly runs to *Epiphragma* (*Polyphragma*) ochrinota Alexander (Luzon), which is its nearest ally. The fly is most readily told by the hypopygial structures, especially of the tergite and interbase. The subgenus had previously been recorded only from Luzon, Mindanao, and Borneo.

LIMNOPHILA (TRICHOLIMNOPHILA) FEROCIA sp. nov. Plate 1, fig. 16; Plate 3, fig. 37.

General coloration of mesonotum opaque grayish brown, the præscutum without evident stripes; antennæ (male) elongate; femora obscure yellow; wings strongly tinged with brown, the base unbrightened; restricted darker brown seams at origin of Rs and along cord and outer end of cell 1st M<sub>2</sub>; abdominal tergites dark brown, sternites brownish yellow; male hypopygium with the median lobe of tergite long and narrow, parallel-sided, the apex truncated; outer dististyle without spinous points on surface; phallosome with the gonapophyses simple, each appearing as a flattened, twisted blade that exceeds the ædeagus in length.

Male.—Length, about 5 millimeters; wing, 5.5 to 5.6; antenna, about 2.7.

Rostrum brownish black; palpi black. Antennæ (male) relatively elongate, as shown by the measurements, the individual segments a little longer than in *platystyla*; scape and pedicel brownish yellow; flagellum black, the extreme base of the first segment restrictedly pale; flagellar segments with verticils that are subequal in length to the segments. Head grayish brown.

<sup>&</sup>lt;sup>5</sup> Philip. Journ. Sci. 49 (1932) 259-261.

Mesonotum opaque grayish brown, without evident stripes. Pleura dark grayish brown. Halteres with stem yellow, the knob dusky. Legs with fore coxæ brown, the remaining coxæ and all trochanters light yellow; femora obscure yellow; tibiæ brownish yellow, the tips narrowly dark brown; tarsi brownish black. Wings (Plate 1, fig. 16) strongly tinged with brown, the color uniform throughout except for darker brown areas at origin of Rs,  $Sc_2$ , stigma, cord, and outer end of cell 1st  $M_2$ ; veins brown, somewhat darker in the infuscated areas. Macrotrichia in outer ends of cells  $R_2$  to  $M_4$ , inclusive, more numerous in outer ends of the cells. Venation:  $Sc_1$  longer than m-cu;  $R_2$  pale but distinct, about one-half  $R_{1+2}$ ; petiole of cell  $M_1$  approximately one-half the cell; m-cu about one-third its length beyond the fork of M.

Abdominal tergites dark brown; sternite brownish yellow. Male hypopygium (Plate 3, fig. 37) with the median lobe of tergite, 9t, long and narrow, the sides nearly parallel, the lateral portions more deflexed; from each outer lateral angle with a strong ridge directed cephalad. Apex of basistyle, b, narrowed into a glabrous subacute point. Outer dististyle, od, strongly flattened, as in platystyla, the surface much wrinkled but without spinous points, as in platystyla and its variety parallela. Inner dististyle, id, with the inner or cephalic lobe very small and weak. Phallosome with the gonapophyses, g, simple, each appearing as a flattened, twisted blade that is longer than the ædeagus, a.

Habitat.—Formosa (north).

Holotype, male, Sozan, altitude 1,000 feet, December 5, 1933 (*Issiki*). Paratopotypes, 2 males.

Limnophila (Tricholimnophila) ferocia is allied to L. (T.) platystyla Alexander and its race, L. (T.) platystyla parallela Alexander, likewise from Formosa, differing most evidently in the distinct structure of the male hypopygium, especially the glabrous outer dististyle, and the simple, very large and conspicuous gonapophyses. In the two forms listed, the latter structure is a profoundly bifid rod, the arms appearing as slender spines. The male sex of L. (T.) excelsa Alexander, from the high mountains of Formosa, is still unknown, but from the coloration it cannot be identical with the present fly.

ELEPHANTOMYIA (ELEPHANTOMYODES) INFUMOSA sp. nov. Plate 1, fig. 17.

General coloration of mesonotum dull brownish orange to reddish brown; head dark brown or brownish black; legs dark

brown, the tarsi extensively snowy white; wings strongly suffused with brown but otherwise unmarked except for the darker stigmal area; abdomen feebly bicolorous.

*Male.*—Length, excluding rostrum, about 6 to 7 millimeters; wing, 6.5 to 7.5; rostrum, about 4.5 to 5.5.

Female.—Length, excluding rostrum, about 6 millimeters; wing, 5.5; rostrum, about 3.5.

Rostrum dark brown, longer in male. Antennæ black throughout. Head dark brown to brownish black, the inner orbits very narrowly grayish.

Mesonotal præscutum dull brownish orange to reddish brown, in female narrowly darker brown on the median area; scutum and scutellum dull brownish orange, the mediotergite somewhat darker brown. Pleura dull brown. Halteres brownish black, the base of stem restrictedly paler, the knob more blackened. Legs with the coxæ brown; trochanters obscure yellow; femora and tibiæ dark brown; basitarsi chiefly dark brown, the narrow tips and all of segments two and three snowy white; outer tarsal segments darkened. Wings (Plate 1, fig. 17) uniformly suffused with brown but otherwise unmarked except for the darker stigmal area; veins brownish black. Venation: m-cu at from one-third to one-half the length of cell 1st M<sub>2</sub>; vein 2d A relatively long, ending at midlength of wing.

Abdomen feebly bicolorous, the tergites dark brown, the basal rings of segments three to five narrowly yellow; sternites more diffusely patterned; outer abdominal segments and hypopygium brownish black.

Habitat.—Northern Celebes (Minahassa).

Holotype, male, Mount Rumengan, Roeroekan, altitude 4,000 feet, April 13, 1931 (*Clagg*); mating on leaf of *Pandanus*. Allotopotype, female, in copula with type. Paratopotypes, 2 males.

In its combination of brownish black head, white tarsi, and unpatterned wings, the present fly is most nearly allied to Elephantomyia (Elephantomyodes) nigriceps Edwards (Siam, Borneo), E. (E.) nigriclava Edwards (Borneo), and E. (E.) samarensis Alexander (Philippines), differing from all in the strongly suffused wings.

#### ERIOPTERINI

# TRENTEPOHLIA (TRENTEPOHLIA) PROBA sp. nov. Plate 1, fig. 18.

General coloration brownish black; humeral region of præscutum a little more reddish brown; knobs of halteres brownish black; wings with the ground color whitish, cross-banded with dark brown; pale band beyond cord almost parallel-sided, only slightly constricted at midlength; no pale spots in outer ends of cells R, M, and Cu; Rs shorter than R  $_{2+8+4}$ ; R $_2$  subequal to R  $_{3+4}$ ; m-cu just beyond fork of M.

Female.—Length, about 7 millimeters; wing, 7.

Rostrum black; palpi brown. Antennæ with the scape black, pedicel dark brown; flagellum broken. Head brownish black; vertex narrowed at a single point.

Pronotum and cervical sclerites black. Mesonotum dull brownish black, the humeral region of præscutum a little more reddish brown. Pleura brownish black, including the dorsopleural region. Halteres yellow, the knobs brownish black. Legs with the coxæ brownish black; trochanters obscure brownish yellow; remainder of legs broken. Wings (Plate 1, fig. 18) with the ground color whitish, cross-banded with dark brown; prearcular region and costal interspaces pale yellow; band of the ground color lying beyond cord almost parallel-sided and thus only slightly constricted along vein  $R_{4+5}$  and  $M_{1+2}$ ; darkened apex variegated by a white spot in outer ends of cells R<sub>3</sub> and R<sub>4</sub>; grayish washes in base of cell  $R_5$  and outer end of cell  $M_2$ ; outer ends of cells in medial dark band not variegated by pale spots, as in *pulchripennis*; veins brown, pale yellow in the clear areas. Venation:  $Sc_1$  ending beyond fork of M; Rs shorter than  $R_{2+3+4}$ ;  $R_2$  subequal to  $R_{3+4}$ ; veins  $R_3$  and  $R_4$  only slightly divergent, the former rather strongly upcurved at costa; m-cu just beyond fork of M.

Abdomen black; ovipositor and genital segment orange.

Habitat.—Formosa (north).

Holotype, female, Urai, altitude about 1,500 feet, May 1, 1932 (Gressitt).

Trentepohlia (Trentepohlia) proba is most nearly allied to T. (T.) pulchripennis Alexander (Formosa), which differs especially in the smaller size, light yellow to brownish yellow mesonotum, yellowish sternum and dorsopleural region, and the distinct venation, especially the long  $R_{3+4}$  which is subequal to the nearly erect  $R_3$ , and the distal position of the fork of M, with m-cu lying more than one-half its length before this fork.

GONOMYIA (LIPOPHLEPS) MITOPHORA sp. nov. Plate 1, fig. 19; Plate 3, fig. 38.

Belongs to the *skusei* group; mesonotal præscutum with three black or brownish black stripes that are confluent or nearly so; pleura reddish yellow to testaceous-yellow; legs dark brown; wings with a faint brown tinge; Sc relatively short for a mem-

ber of the group, Sc<sub>1</sub> ending shortly beyond origin of Rs; male hypopygium with the outer lobe of basistyle unusually long, cylindrical; dististyles of the two sides slightly asymmetrical.

Male.—Length, about 4.5 to 5 millimeters; wing, 4.5 to 5.

Female.—Length, about 5.5 to 6 millimeters; wing, 5 to 5.3.

Rostrum and palpi black. Antennæ black throughout; flagellar segments (male) with elongate verticils, as in the group. Head dark.

Pronotum darkened medially, yellow on sides. Mesonotal præscutum chiefly covered by black or brownish black stripes that are nearly or quite confluent, reducing or obliterating the usual interspaces; scutal lobes almost covered by black areas. the broad median region and the scutellum pale yellow; mediotergite reddish yellow. Pleura uniformly reddish yellow to testaceous-yellow, without distinct stripes. Halteres pale yellow, the base of knob a trifle darkened. Legs with the coxæ obscure yellow, the fore coxæ a trifle darker; trochanters yellow; remainder of legs uniformly dark brown. Wings (Plate 1, fig. 19) with a faint brown tinge, the stigmal area scarcely darkened; veins pale brown. Venation: Sc, ending a trifle beyond the origin of Rs, Sc<sub>2</sub> opposite or close to this origin; basal section of R<sub>5</sub> of variable length, in cases very much reduced; branches of Rs elongate, more or less parallel on basal third; cell 1st M2 closed; m-cu at or beyond the fork of M.

Abdominal tergites brownish yellow, the sternites more yellowish, with a more or less definite median darkening; hypopygium relatively large and conspicuous. Male hypopygium (Plate 3, fig. 38) with the outer lobe of basistyle, b, unusually long and slender, cylindrical, pale, with long erect setæ on mesal face. Distityles, d, of the two sides slightly asymmetrical, in one the apical spine long and slender, gently sinuous, on the opposite side the corresponding spine shorter, more flattened, sinuous. Phallosome, p, a flattened compressed blade, bearing a large spinous point on basal third where the structure is strongly narrowed, thence dilated into a spatula.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 3,800 feet, May 15, 1931 (*Clagg*). Allotopotype, female. Paratopotypes, 12 of both sexes, May 15–16, 1931.

Gonomyia (Lipophleps) mitophora is readily told from all allied species of the subgenus by the coloration, venation, and structure of the male hypopygium. I am referring it to the

skusei group, despite the relatively short Sc which, in some cases, extends only to a slight distance beyond the origin of Rs.

GONOMYIA (LIPOPHLEPS) PERVILIS sp. nov. Plate 1, fig. 20; Plate 3, fig. 39.

Allied to diacantha; male hypopygium with the outer dististyle stout on basal half, the outer portion produced into a long smooth rod, at base on mesal edge with two blackened spines; cephalic-mesal portion of style further produced into a slender darkened rod; inner dististyle terminating in a relatively short spine; phallosome consisting chiefly of two flattened pale blades.

Male.—Length, about 3 millimeters; wing, 3.8.

Rostrum and palpi black. Antennæ chiefly black, the pedicel a little brightened. Head chiefly dark gray.

Pronotum and anterior lateral pretergites pale yellow. Mesonotum chiefly gray, the humeral region of præscutum restrictedly brightened; scutellum vaguely brightened on basal portion. Pleura dark, with a conspicuous silvery white longitudinal stripe extending from behind the fore coxe to the meral region. Halteres dusky, the knobs obscure yellow. Legs with the fore coxæ brownish yellow; remaining coxæ darker; trochanters brownish testaceous; femora pale brown, the bases a little brightened, the tips narrowly darker brown; tibiæ and tarsi dark brown; femora with a row of evenly spaced erect setæ on ventral face, longer and more conspicuous on posterior femora. Wings (Plate 1, fig. 20) whitish subhyaline, clouded with darker. including major areas in all basal cells, especially R, along cord and in outer radial field; stigma long-oval, dark brown; veins brown, more yellowish in the ground areas. Venation: Sc, ending a short distance before the origin of Rs, the degree a little shorter than m-cu; anterior branch of Rs paralleling R1; r-m long, arcuated; m-cu before the fork of M.

Abdomen dark brown; hypopygium yellow. Male hypopygium (Plate 3, fig. 39) with the outer dististyle, od, stout on basal portion, the outer part produced into a long, gently arcuated rod, its tip obtuse, the margin smooth; at base of this rod, on inner aspect with two blackened spines, the mesal one a little longer; on mesal face of style near base a further slender dark arm that bears a small subapical spine. Inner dististyle, id, with the apical spine short. Phallosome, p, appearing chiefly as two flattened pale blades that fill the whole genital chamber.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 3,800 feet, May 17, 1931 (Clagg).

Gonomyia (Lipophleps) pervilis is most nearly allied to G. (L.) diacantha Alexander (Mindanao), differing conspicuously in the structure of the phallosome and outer dististyle.

## GONOMYIA (LIPOPHLEPS) GRESSITTI sp. nov. Plate 3, fig. 40.

Belongs to the *diffusa* group; male hypopygium with three dististyles, the intermediate one a long simple pale spine; inner style widely separated from the outer, appearing as a flattened blade that is narrowed on outer third into a slenderer blade whose base is surrounded by several setæ.

Male.—Length, about 3 millimeters; wing, 3.5.

Rostrum and palpi dark. Antennæ with scape dark; remainder of antennæ broken. Head chiefly dark.

Anterior lateral pretergites light yellow. Mesonotal præscutum and scutum brownish gray; humeral region of the former restrictedly paler; scutal lobes with posterior callosities light yellow; scutellum with posterior border broadly pale yellow. Pleura chiefly dark brown with a conspicuous silvery white longitudinal stripe, extending from above the fore coxæ to the base of abdomen. Legs with the femora obscure yellow, with a broad black terminal (forelegs) to nearly terminal ring; tibiæ obscure yellow, the bases and tips narrowly blackened; basitarsi obscure brownish yellow, the tips and remainder of tarsi black. Wings with a faint grayish tinge; stigma barely evident; veins pale brown. Venation: Sc relatively long, Sc<sub>1</sub> ending shortly before origin of Rs, Sc<sub>2</sub> close to its tip; anterior branch of Rs nearly straight and extending nearly parallel to R<sub>1</sub>; m-cu shortly before the fork of M.

Abdominal tergites black, the caudal borders of the segments narrowly yellow. Male hypopygium (Plate 3, fig. 40) of the general type of *jacobsoniana* or *ramifera*, differing in all details. Outer dististyle, od, a gently arcuated simple rod; intermediate style, md, nearly as long, appearing as a slender pale needlelike spine; inner style, id, placed low down on the mesal face of basistyle, as in the group, appearing as a flattened blade, on about the outer third suddenly narrowed into a slenderer blade, at base of the latter with a group of several coarse setæ; base of inner style on cephalic portion with a group of setæ.

Habitat.—Formosa (south).

Holotype, male, Rokki, near river, altitude 400 to 500 feet, June 14, 1932 (Gressitt).

I take great pleasure in naming this distinct species in honor of the collector, Mr. J. Linsley Gressitt, to whom I am indebted

for several interesting Tipulidæ from Honshiu and Formosa. The nearest allies are *Gonomyia* (*Lipophleps*) *jacobsoniana* Alexander and G. (L.) ramifera Alexander (Sumatra to Mindanao), which differ most evidently in the structure of the male hypopygia.

## ORMOSIA DIVERSIPENNIS sp. nov. Plate 1, fig. 21.

Mesonotal præscutum and scutum light brown, the posterior sclerites of mesonotum and the pleura darker brown; knobs of halteres light yellow; legs yellow, the femora with a narrow brown subterminal ring and indications of a broader but more diffuse annulus before midlength; wings buffy yellow, variegated over the entire surface by abundant patches of dark-colored trichia; outer ends of marginal cells yellow; abdomen dark brown.

Female.—Length, about 4 millimeters; wing, 4.8.

Rostrum brown; palpi brownish black. Antennæ brown, the flagellar segments vaguely bicolorous by having their apices slightly pale. Head dark brown, with conspicuous yellow setæ.

Mesonotal præscutum light brown, without markings; pseudosutural foveæ black, the tuberculate pits small and paler; setæ of interspaces yellow, long, and conspicuous; scutum light brown; scutellum and mediotergite darker brown, with indications of a dark median dash on scutum and scutellum. Pleura darker brown than the præscutum. Halteres pale, the knobs large, light yellow. Legs with the coxe brown; trochanters brownish yellow; femora yellow, with a narrow brown subterminal ring; most of the femora are also more or less darkened on basal half, leaving a broad ring of the ground color at and beyond midlength; tibiæ and tarsi light yellow, the outer tarsal segments darker. Wings (Plate 1, fig. 21) with the ground color buffy yellow, the costal and apical borders extensively brighter yellow; entire surface of wing variegated by large patches of darkcolored trichia, these occurring in almost all cells; trichia elsewhere on disk light yellow, the total area of light and dark patches being not greatly disproportionate; conspicuous yellow areas at ends of all marginal cells; veins yellow, darker in the clouded areas. Macrotrichia of cells long and conspicuous. nation: Tips of veins R<sub>3</sub> and R<sub>4</sub> strongly deflected cephalad; cell 1st M<sub>2</sub> open by atrophy of basal section of M<sub>3</sub>.

Abdomen dark brown. Valves of ovipositor long and conspicuous, dark horn-color.

Habitat.—Formosa (south).

Holotype, female, Sekisan, altitude 6,000 feet, August 15, 1933 (*Issiki*).

Ormosia diversipennis is readily told from allied regional species of the genus by the pattern of the wings and legs, especially the former.

CRYPTOLABIS (BÆOURA) CONSOCIA sp. nov. Plate 1, fig. 22; Plate 3, fig. 41.

General coloration dark gray; antennæ black throughout; legs black, the setæ not conspicuously outspreading; scutellum behind broadly yellow; male hypopygium with the dististyle strongly narrowed on outer half into a fingerlike lobe; gonapophysis a flattened blade that bears two large triangular points.

Male.—Length, about 4.5 millimeters; wing, 4.8.

Rostrum dark above, yellow laterally; basal segments of palpi obscure yellow, the outer segments blackened. Antennæ black throughout, the scape a little pruinose; pedicel larger than the scape; basal flagellar segments short-oval to subcylindrical, the outer segments more elongate, with conspicuous verticils. Head light gray.

Pronotum brownish gray, narrowly yellow on sides. rior lateral pretergites yellow, variegated by dark brown spots. Mesonotal præscutum dark gray, with indications of a darker median stripe; scutum similarly darkened, the outer lateral portions more yellow; scutellum dark basally, the margin broadly yellow; mediotergite gray. Pleura gray; dorsopleural mem-Halteres dusky. Legs with the coxæ dark; trobrane paler. chanters brownish testaceous; remainder of legs black, with chiefly yellow setæ of moderate length. Wings (Plate 1, fig. 22) with a grayish tinge, the prearcular and costal regions more nearly whitish; stigma faintly indicated; scarcely evident darkenings along cord; veins brown. Venation: Sc, ending just before R<sub>2</sub>, Sc<sub>2</sub> some distance from its tip; R<sub>3</sub> lying close to  $\mathbf{R}_{1+2}$ , a little constricting the cell before midlength; m-cu more than three-fourths its length beyond the fork of M; cell 2d A wide.

Abdomen, including hypopygium, dark brown. Male hypopygium (Plate 3, fig. 41) with the tergite, 9t, conspicuous, the outer lateral angles appearing as glabrous, obtuse, earlike lobes. Dististyle, d, with the outer half strongly narrowed into a finger-like lobe. Gonapophyses, g, appearing as pale yellow flattened blades, with two strong triangular points, the lateral point or spine larger than the apical one; outer margin of outer point and lower margin of lateral one with microscopic denticles.

Habitat.—Formosa (central).

Holotype, male, Heiganzan to Pianan-Anbu, Taichû-shû, July 19, 1932 (Esaki).

Cryptolabis (Bxoura) consocia is most nearly allied to C. (B.) aliena (Alexander), differing especially in the details of structure of the male hypopygium. The hypopygium of aliena is shown for comparison (Plate 3, fig. 42), the most conspicuous differences being the more evident ears of the tergite, 9t, the longer apical point of the dististyle, d, and, especially, the differently shaped gonapophyses, g, with the outer point or lobe obtuse and microscopically roughened, the lateral point a very long and slender, gently arcuated blade.

CRYPTOLABIS (BÆOURA) LÆVILOBATA sp. nov. Plate 1, fig. 23; Plate 3, fig. 43.

General coloration of thorax and abdomen dull black; head light gray; setæ of legs long and conspicuous, erect; wings almost uniformly tinged with blackish, the apical cells paler; male hypopygium with the tergite strongly narrowed outwardly, terminating in two slender glabrous lobes that are separated from one another only by a deep U-shaped notch, the margins of the lobes smooth; fused gonapophyses with a median lobule between the short fleshy arms.

Male.—Length, about 4 millimeters; wing, 4.6.

Female.—Length, about 4 millimeters; wing, 5.4.

Rostrum dark brown; palpi black. Antennæ black throughout. Head light gray.

Mesonotum almost entirely deep black, only moderately polished; scutellum obscure yellow. Pleura dull black. Halteres with the stem dark, the base narrowly pale, the knob yellow. Legs with the coxe and trochanters brownish black; remainder of legs brownish black, conspicuously hairy. Wings (Plate 1, fig. 23) with an almost uniform blackish tinge, the apex narrowly paler; stigma appearing as a linear darkened seam on  $R_{1+2}$ ; veins and macrotrichia black. Venation:  $Sc_1$  ending shortly beyond the fork of Rs,  $Sc_2$  some distance before this fork;  $R_{2+3}$  a trifle longer than  $R_2$  alone; m-cu close to midlength of  $M_{3+4}$ .

Abdomen dull black, including the genitalia of both sexes. Male hypopygium (Plate 3, fig. 43) with the ninth tergite, 9t, strongly narrowed outwardly, terminating in two slender glabrous lobes that are separated from one another only by a deep and narrow U-shaped notch; margins of the lobes smooth and without setæ. Dististyle, d, shorter than in trichopoda. What

are interpreted as being gonapophyses, g, appear as two short divergent arms, with the median area produced to lie beyond the level of these arms.

Habitat.—Formosa (north).

Holotype, male, Rimozan, May 2, 1933 (Issiki). Allotopotype, female.

The nearest ally of the present fly is undoubtedly *Cryptolabis* (*Bxoura*) trichopoda Alexander (southern Formosa) which, while very similar in general appearance, yet is conspicuously different in the structure of the hypopygium. It should be noted that these two species have the internal structures of the hypopygium very different from the other Formosan species, the large and prominent gonapophyses of aliena Alexander and consocia sp. nov., here being lacking or greatly reduced in size, or else being represented by the fused median structure (Plate 3, fig. 43, g), which would then form a phallosomic structure similar to that found in the genus *Molophilus*.

CRYPTOLABIS (BÆOURA) TRICHOPODA HASSENENSIS subsp. nov. Plate 3, fig. 44. Male.—Length, about 4 millimeters; wing, 4.6.

Characters as in typical *trichopoda* Alexander, differing especially in slight details of structure of the male hypopygium (Plate 3, fig. 44). Ninth tergite, 9t, with the lateral lobes very conspicuous, separated by a U-shaped notch, the flattened margins of the lobes with delicate serrations. Dististyle, d, more evenly curved.

Habitat.—Formosa (central).

Holotype, male, Hassenzan, Kahodai to Reimei, Taichû-shû, July 12, 1932, (Esaki).

MOLOPHILUS CELEBESICUS sp. nov. Plate 1, fig. 24; Plate 3, fig. 45.

Belongs to the *gracilis* group and subgroup; general coloration black; antennæ (male) of moderate length, brownish black throughout; wings very strongly tinged with brownish black; male hypopygium with all lobes of basistyle obtuse at tips; outer dististyle a slender, nearly straight rod, the outer end microscopically roughened; inner dististyle of similar length but broader, at near two-thirds the length with the margin produced into an acute blackened spine.

Male.—Length, about 3.8 to 4 millimeters; wing, 4.6 to 4.8. Rostrum and palpi black. Antennæ (male) moderately elongate, if bent backward extending to the wing root, brownish black throughout. Head black, with a sparse pruinosity.

Mesonotum black, the anterior lateral pretergites restrictedly more reddish brown. Pleura dull black. Halteres brownish black. Legs brownish black throughout. Wings (Plate 1, fig. 24) very strongly suffused with brownish black; veins a little darker than the ground color; macrotrichia unusually long and conspicuous. Venation:  $R_2$  lying shortly beyond the level of r-m; vein 2d A extending to about opposite the basal fifth of the petiole of cell  $M_3$ .

Abdomen, including the hypopygium, black. Male hypopygium (Plate 3, fig. 45) with all lobes of basistyle, b, obtuse, unarmed with spinous points. Outer dististyle, od, a small, slender, nearly straight rod, its outer end microscopically roughened. Inner dististyle, id, of about the same length as the outer, appearing as a straight flattened rod, at near two-thirds the length with the margin produced into an acute black spine, surrounding the base of which are several delicate setæ, additional to the rather numerous setigerous punctures elsewhere on the sclerite.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 4,500 to 6,000 feet, May 25, 1931 (*Clagg*). Paratopotypes, 3 males.

Molophilus celebesicus is very different from all other black species of the genus in the structure of the male hypopygium, more especially of the inner dististyle.

# ILLUSTRATIONS

[a, Ædeagus; b, basistyle; d, dististyle; dd, dorsal dististyle; g, gonapophysis; i, interbase; id, inner dististyle; md, intermediate dististyle; od, outer dististyle; p, phallosome; t, tergite; vd, ventral dististyle.]

#### PLATE 1

- Fig. 1. Tipula (Lunatipula) multibarbata sp. nov., venation.
  - 2. Dolichopeza (Nesopeza) toala sp. nov., venation.
  - 3. Dolichopeza (Nesopeza) profundemarginata sp. nov., venation.
  - 4. Dolichopeza (Nesopeza) toraja sp. nov., venation.
  - 5. Limonia (Libnotes) falsa sp. nov., venation.
  - 6. Limonia (Libnotes) comissabunda sp. nov., venation.
  - 7. Limonia (Limonia) alopecura sp. nov., venation.
  - 8. Limonia (Limonia) inscita sp. nov., venation.
  - 9. Limonia (Euglochina) curtata sp. nov., venation.
  - 10. Helius (Helius) copiosus sp. nov., venation.
  - 11. Orimarga (Orimarga) gymnoneura sp. nov., venation.
  - 12. Orimarga (Orimarga) griseipennis sp. nov., venation.
  - 13. Orimarga (Orimarga) toala sp. nov., venation.
  - 14. Orimarga (Orimarga) hypopygialis sp. nov., venation.
  - 15. Epiphragma (Polyphragma) minahassana sp. nov., venation.
  - 16. Limnophila (Tricholimnophila) ferocia sp. nov., venation.
  - 17. Elephantomyia (Elephantomyodes) infumosa sp. nov., venation.
  - 18. Trentepohlia (Trentepohlia) proba sp. nov., venation.
  - 19. Gonomyia (Lipophleps) mitophora sp. nov., venation.
  - 20. Gonomyia (Lipophleps) pervilis sp. nov., venation.
  - 21. Ormosia diversipennis sp. nov., venation.
  - 22. Cryptolabis (Bæoura) consocia sp. nov., venation.
  - 23. Cryptolabis (Bxoura) lxvilobata sp. nov., venation.
  - 24. Molophilus celebesicus sp. nov., venation.

## PLATE 2

- Fig. 25. Tipula (Lunatipula) multibarbata sp. nov., male hypopygium, details.
  - 26. Tipula (Lunatipula) multibarbata sp. nov., male hypopygium, eighth sternite.
  - 27. Dolichopeza (Nesopeza) toala sp. nov., male hypopygium, details.
  - Dolichopeza (Nesopeza) profundemarginata sp. nov., male hypopygium, details.
  - Dolichopeza (Nesopeza) toraja sp. nov., male hypopygium, details.
  - 30. Limonia (Libnotes) falsa sp. nov., male hypopygium.
  - 31. Limonia (Limonia) alopecura sp. nov., male hypopygium.
  - 32. Limonia (Limonia) inscita sp. nov., male hypopygium.
  - 33. Helius (Helius) copiosus sp. nov., male hypopygium.
  - 34. Orimarga (Orimarga) gymnoneura sp. nov., male hypopygium.
  - 35. Orimarga (Orimarga) hypopygialis sp. nov., male hypopygium.

## PLATE 3

- FIG. 36. Epiphragma (Polyphragma) minahassana sp. nov., male hypopygium.
  - 37. Limnophila (Tricholimnophila) ferocia sp. nov., male hypopygium.
  - 38. Gonomyia (Lipophleps) mitophora sp. nov., male hypopygium.
  - 39. Gonomyia (Lipophleps) pervilis sp. nov., male hypopygium.
  - 40. Gonomyia (Lipophleps) gressitti sp. nov., male hypopygium.
  - 41. Cryptolabis (Bæoura) consocia sp. nov., male hypopygium.
  - 42. Cryptolabis (Bæoura) aliena Alexander, male hypopygium.
  - 43. Cryptolabis (Bæoura) lævilobata sp. nov., male hypopygium.
  - 44. Cryptolabis (Bæoura) trichopoda hassenensis subsp. nov., male hypopygium.
  - 45. Molophilus celebesicus sp. nov., male hypopygium.

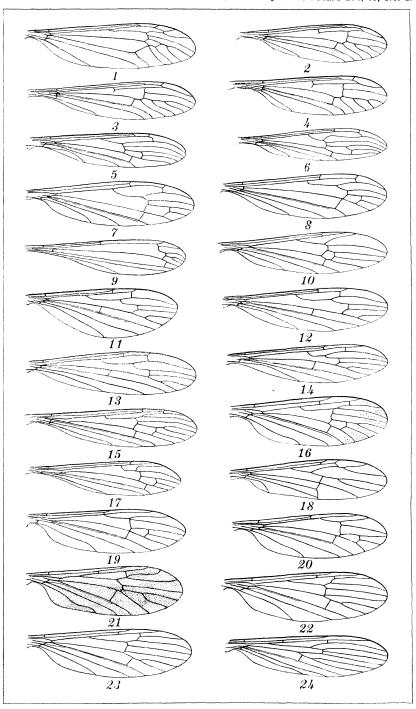


PLATE 1.

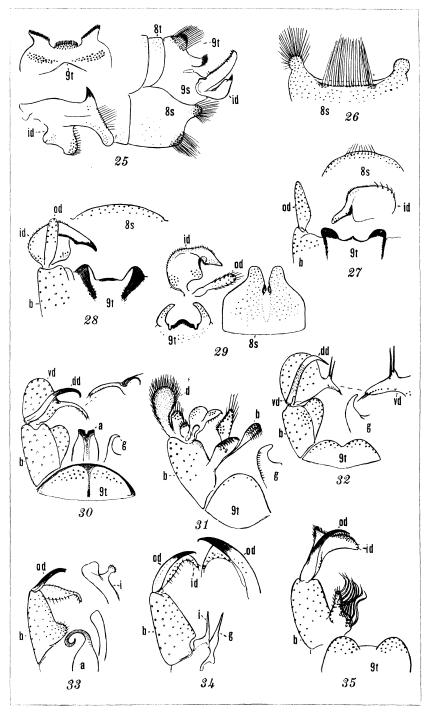


PLATE 2.



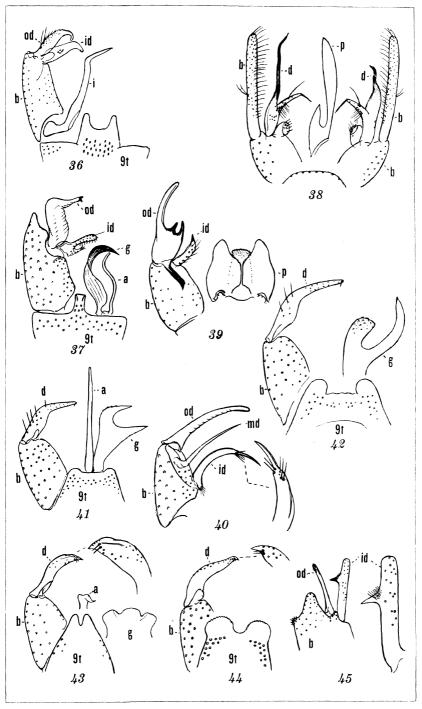


PLATE 3.



# THE PHYSIOLOGY OF REPRODUCTION IN SWINE, III

## PRELIMINARY STUDY OF THE MORPHOLOGY OF THE SPERMATOZOA 1

## By AGUSTIN RODOLFO

Formerly Geneticist, All-Union Research Institute for Swine Husbandry Poltava, Ukraine, U. S. S. R.

## ONE PLATE

The presence of three different types of spermatozoa in the semen of the boar, the relative number of which is fairly constant, evokes considerable interest. They are distinguishable from one another by the absence or presence on the flagellum of a protoplasmic drop and by the position assumed by the drop on the tail. Measurements made of these types show that they also differ in size. On the significance of these different types, however, no information can be given here.

## TYPES OF SPERMATOZOA

The spermatozoa of the boar are of three different types, which for present purposes may be designated I, II, and III, as on Plate 1.

The second type has the droplike protoplasmic structure attached on the proximal end of the middle piece, just below the neck, and the third has it at about the end of the upper third of the flagellum. This droplike structure appears to be a remnant of the cytoplasm of the differentiating spermatid. The first, which does not have the protoplasmic drop, is taken to be the normal type, largely because it ordinarily constitutes the greatest number in the semen.

The manner of attachment of the "drop" to the flagellum can best be studied by focusing the 4-mm objective up and down with the fine adjustment on a specimen that is still moving normally but relatively slowly. Such a specimen is suitable for study because no postmortem changes have set in, and because whether or not the "drop" surrounds the flagellum can be ade-

<sup>&</sup>lt;sup>1</sup> This is the third paper of a series, the materials for which were worked out during the writer's stay in Soviet Russia.

quately observed. The difference in refractive index between the flagellum and the "drop" enables one to determine that the "drop" surrounds the flagellum completely. The flagellum is straight at the point where the "drop" is attached. In most specimens observed, the "drop" surrounded the tail symmetrically; in a few cases, however, symmetry is lacking.

The development of these types can be traced. If samples of spermatozoa are taken from the different parts of the epididymis, going from the proximal towards the distal portion, two facts become evident. First, the motility of the spermatozoa gradually increases as they move away from the proximal portion and approach the distal portion of the epididymis. In the proximal portion of the epididymis only nonmotile spermatozoa are encountered, while in the caudal portion only motile types are normally present. Second, most of the spermatozoa undergo a transformation from type II to type III, and finally to type I. From the proximal part of the epididymis only type II spermatozoa are present. As samples are taken towards the middle portion of the epididymis, type III soon makes its appearance, and gradually increases in number while type II correspondingly Finally type I appears, gradually becoming more decreases. numerous until it predominates over both types II and III. Not all spermatozoa, however, undergo the full process of transformation from type II to III and finally to I; some remain as type II and others as type III.

This phenomenon is not confined to the boar. Other workers, notably Hammar (1897) in the dog, Tournade and Regaud (1911) in the rat, Tournade (1913) in the rat, rabbit, guinea pig, and dog, and Young (1929) in the guinea pig, rat, ram, and bull, have observed that the spermatozoa removed from the proximal portion of the epididymis are nonmotile, or at most only slightly motile, while those removed from the posterior levels are motile.

Thus it appears that the spermatozoa undergo a sort of maturation in the epididymis and that type II is the most primitive form, III an intermediate form, and I the predominating type in the ordinary semen, the completely differentiated or matured type. From this standpoint both types II and III may be considered as immature types, type III being the more differentiated of the two.

On the other hand, if types II and III in the semen are immature—that is, not fully differentiated—two things are logically

to be expected; namely, (a) the proportion of types II and III to type I in the semen should increase in the course of intensive mating; and (b) there should be no distinct measurable differences among these types.

(a) The relative proportions of the three types in intensively mated boars.—The more intensively a boar is mated, the greater is the demand for the ejection of spermatozoa, and the shorter is the stay of the spermatozoa in the epididymis. During the early part of a period of intensive mating the normal expectation is for the ejection of type I and only a few of types II and III. if any. Now, in the first place the fact that the second mating in a day gives only a relatively meager number of spermatozoa, in spite of the presence in the epididymis of a greater number of spermatozoa than can be ejected in a number of ejections, was adduced in the first paper of this series as the basis for the suggestion that the spermatozoa need a certain minimum length of time in order to complete the process of transformation from the nonmotile type II to the motile types at the caudal portion of the epididymis. If this be so, one would expect that in the later part of a period of intensive mating—since there is less and less time for the transformation of the spermatozoa from types II and III to I—the proportion of immature gametes should increase with, at least in direct proportion to, the intensiveness of the mating and the progress of the period. Tables 1 to 3 show what takes place in the relative numbers of these various types as the boars are mated intensively.

Table 1.—Relative numbers of the three types of spermatozoa of boars mated twice every other day.

_	Time		July 2.			July 3.	•		July 4.	
Boar No.	of day.	I	II	III	I	II	III	I	II	III
2485/27	a. m p. m		5 5	59 28	(d)	(d)	(d)	465 500		35
2486/28	(p. m [a. m [p. m	422	1 4	77 68	(d)	(d)	(q)	486 492	1	13 8
2196/87	a. m		(a) (a)		270	(°) 145	85		(d)	
1887/284	a. m p. m		(a)		355	43 (b)	102		(q)	
2200/91	a. m p. m		(a)		130	302 (°)	68		(q)	

<sup>\*</sup> Not mated.

b Did not mate.

c No spermatozoa in secretion.

d Rest.

TABLE 1 .- Relative numbers of the three types of spermatozoa of boars mated twice every other day-Continued.

	Time	July 5.			July 6.			July 7.			July 8.		
Boar No.	of day.	I	II	Ш	I	п	Ш	I	11	III	I	п	Ш
2485/27	a. m p. m	(d)	(q)	(q)	496 500		4	(d)	(d)	(q)	500 499		1
2486/28	a. m p. m	(q)	(q)	(q) (q)	498 475	6	2 19	(d)	(q)	(q)	494 496	3	3
2196/87	a, m p. m	461 500	16	23		(d)		471	16 (b)	13		(a) (a)	
1887/284	a. m p. m	418 491	7	75 9		(q) (q)			(p) (p)			(a) (a)	
2200/91	a. m p. m	165	261 (b)	74		(d)			(p)			(a) (a)	

a Not mated.

TABLE 2.—Relative numbers of the three types of spermatozoa of boars mated once every day.

June 21.			J	une <b>22.</b>		June 23.			
1	II	III	I	II	Ш	I	II	Ш	
498	(a) 2 (a)		500 500 362	121	17	500 452	(b) 42	6	
June 24.			June 25.			June 26.			
I	II	III	I	II	III	I	11	III	
500 500 490	10		500 500 500			495 493	5 (b) 7		
	1 498 	I II (a) 498 2 (a)  June 24  I II  500	I II III  (*) 498 2 (*)  June 24.  I II III  500 500	I II III I  (a) 500 498 2 500 362  June 24.  I II III I  500 500 500 500	I         II         III         I         II	I         II         III         I         II         III	I     II     III     I     II     III     I	I         II         III         I         II         III         I         III         I         III         IIII         IIII         IIII         IIII         IIII	

a Not mated.

Table 3 .- Relative numbers of the three types of spermatozoa in 10-monthold boars mated twice a day.

Boar No.	Time		June 28	<b>3.</b>		June 29	
Dogr No.	of day.	I	II	111	I	11	III
2782/298	a. m p. m	477	4 (b)	19		(d)	
2705/194	a. m p. m	497	1	2		(q) (q)	

b Did not mate.

<sup>&</sup>lt;sup>b</sup> Did not mate. <sup>c</sup> No spermatozoa in secretion.

d Rest.

<sup>&</sup>lt;sup>b</sup> Did not mate.

<sup>4</sup> Rest.

D V.	Time		June 30.	•		July 1.			July 2.	,
Boar No.	of day.	I	II	III	I	II	III	I	п	III
2782/298	a. m	484	7	9		(d)			(b)	
2705/194	(p. m  a. m	480 489 494	4	16 11 6		(d)			(р) (р)	

Table 3.—Relative numbers of the three types of spermatozoa in 10-monthold boars mated twice a day—Continued.

The counts were made from three slides prepared from the samples of semen soon after collection. The slides, made from semen well shaken and mixed, may be considered as constituting a good random sample of semen. From the spermatozoa in the preparations a random sample of 500 spermatozoa was taken. As each spermatozoon was come upon, it was classified according to type. In this manner the relative numbers of each of the three types were determined.

Tables 1 to 3 give the relative numbers of the three types of spermatozoa in the semen of boars under different intensivenesses of mating. Table 1 may be said to give the highest degree of intensiveness of mating. The boars in Table 1 being mated twice a day every other day did within twelve hours during the day of mating the work that the boars in Table 2 did in two days. As a general rule, the boars in Table 1, by doing the work at a faster rate, tired faster and took more time to get rested than the boars in Table 2. Moreover, at least in the case of boars 2485/27 and 2486/28, there were eight matings in the course of seven days or an average of over one mating a day; those in Table 2 mated only five times in as many days. Boar 2615/91 took five days for four matings.

As has been noted above, because the demand for spermatozoa is greatly increased during intensive mating over that during light mating, the relative proportion of types II and III to type I in the semen should increase, especially during the later part of an intensive-mating period. Tables 1 to 3 fail to satisfy this expectation. Table 1 shows instead, if anything, a tendency for the number of types II and III to decrease.

The tables further show that the different boars seem to possess different abilities to produce these different types. Boars 2564/34 and 2200/91 contrast in this respect. The former pro-

<sup>&</sup>lt;sup>b</sup> Did not mate.

d Rest.

duced few of either type II or III—less than 0.5 per cent; on the other hand, boar 2200/91 is interesting in that his semen contained at one time a preponderance of type II over either type I or III, and even over both. The other boars examined show type I preponderating overwhelmingly over both types II and III.

The condition of the preponderance of type II over types I and III in the semen of boar 2200/91, July 3 and 5, was, however, a temporary condition, as Table 4 shows.

Table 4.—Relative numbers of the three types in the semen of boar 2200/91 at different dates.

		Туре.		Total
Date.	I	11	III	spermatozoa.
July 3	130 165 477	302 261 11	68 74 12	$1.83 \times 10^{10}$ $239 \times 10^{10}$ $11.07 \times 10^{10}$

In the case of this boar, at least, the big production of types II and III is associated with a small production of spermatozoa. July 3, even after a rest of thirteen days from his last mating. the boar gave only 1.83 by 10 10 spermatozoa, and July 5, 2.39 by 10 10, almost double his production two days before. whereas August 15, after a rest of thirteen days, he gave 11.07 by 10 <sup>10</sup> spermatozoa. July 3 and 5, when the boar produced an abnormally small number of spermatozoa, types II and III were abnormally numerous, type II even predominated over types I and III. August 15, however, when he produced a normal number of spermatozoa, the relative number of types II and III was small. It would seem, therefore, as if the ejection of large numbers of types II and III were correlated with the production of abnormally small numbers of spermatozoa. In that case it is not improbable that the ejection of large numbers of types II and III is in some way due to an abnormal physiological condition in the boar.

This consideration raises the question of whether types II and III are abnormal. There are two facts that seem to contradict the idea that they are abnormal. First, their longevity is not less than that of type I. They have been observed actively and normally moving thirty-two hours after the collection of the semen, which was kept at 15° C. This is about as long as any type will live in vitro in undiluted semen at 15° C.

Second, abnormal products usually assume different shapes. As will presently be shown, measurements taken of the different types tend to show them to be distinct from one another and of little variability.

(b) Measurements of the spermatozoa.—Three hundred of each of the three types have been measured from the preparations by means of the ocular micrometer. The total length and the length and width of the head were the dimensions taken. In addition to these the distance from the tip of the acrosome to the "drop" was also taken in the case of type II. The individual spermatozoa measured were taken at random. The only selecting done was in picking out the individuals that were fairly straight; curled ones could not be measured accurately. The statistical treatment of the measurements is summarized in Table 5.

Table 5.—Measurements of the three types of spermatozoa of the boar.

	Distance from acrosome to "knob."								
Type.	Μ. μ	S. D.	Μ. μ	S. D.					
III	$61.69 \pm 0.095$ $50.93 \pm 0.084$ $52.27 \pm 0.065$	$\begin{array}{c} 2.46 \pm 0.067 \\ 2.16 \pm 0.059 \\ 1.68 \pm 0.046 \end{array}$	15.42±0.039	1.015+0.028					
	Head.								
Туре.	Len	gth.	Bre	adth.					
	Μ. μ	S. D.	Μ. μ	S. D.					
II	$8.013 \pm 0.022$ $7.788 \pm 0.019$ $8.047 \pm 0.019$	$0.555 \pm 0.015$ $0.473 \pm 0.013$ $0.500 \pm 0.014$	$4.20 \pm 0.013  4.04 \pm 0.014  4.26 \pm 0.012$	$0.328 \pm 0.009 \\ 0.361 \pm 0.010 \\ 0.307 \pm 0.008$					

Table 6.—Differences between the means of the three types of spermatozoa of the boar.

	Total length.	Head.				
Type.	Total length.	Length.	Breadth.			
I-II	51.69—50.93 = 0.76± 0.128	8.913—7.788— 0.225±0.029	4.20-4.04 = 0.16±0.019			
III-II	$\begin{array}{c} 52.27 - 50.93 = \\ 1.34 \pm 0.106 \end{array}$	$8.047 - 7.788 = 0.259 \pm 0.027$	$4.26-4.04 = 0.22 \pm 0.018$			
III-I	$\begin{cases} 52.27 - 51.69 = \\ 0.58 \pm 0.116 \end{cases}$	$8.047 - 8.013 = 0.034 \pm 0.029$	$\begin{array}{c} 4.26 - 4.20 = \\ 0.06 \pm 0.017 \end{array}$			

Table 6, in which the significance of differences among the respective means are tested, shows that all the differences, except one—the exception being the difference between the length of head of types III and I—being more than three times their respective probable errors, may be considered at least almost certainly significant. According to the results type II is the smallest, type III the largest, and type I intermediate. Of course, the number measured is relatively small, and the smallness of the sample might invalidate the results obtained; but if each one of the samples could be considered a random sample the smallness of the numbers would not invalidate the results.

The results of the measurements are somewhat unexpected. If type II be the primitive type, as the evidence tends to show, then being the relatively undifferentiated type, it should be the largest; for some energy must be consumed in the process of differentiation, which would tend to reduce the size of the cells—unless the source of the energy needed for differentiation should be entirely of extra-cellular origin. There may possibly exist a mechanism that predestines the development of each spermatid into a particular type.

At all events, the evidence tends to show that these three types differ from one another not only in the absence or presence of a protoplasmic drop and on the position assumed by such a drop on the tail, but also in size. Furthermore, the variability of the different types is quite small, as gauged by their respective standard deviations.

There is no intergrading between types II and III. In other words, the protoplasmic drop seems to be either on the neck or towards the middle of the tail, but not in between. It seems then that there is no transformation from type II to type III in the semen; for were such a transformation taking place in the semen it should be possible to demonstrate it by showing that the curve of distribution of the protoplasmic drop is more or less a flat curve. The standard deviation of the measurement of the distance between the acrosome and the protoplasmic drop in type III would be large, and the position of the drop should vary all the way from the neck, its position in type II, to about the middle of the tail, its position in type III—which does not happen to be the case.

# SUMMARY

- 1. The three types of spermatozoa observed in the semen of the boars studied represent morphological stages in their development. They differ from one another by the absence or presence of a protoplasmic drop and by the position assumed by the drop on the tail. Type I has no protoplasmic drop, type II has the drop on the neck, and type III towards the middle of the tail.
- 2. The spermatozoa are transformed from type II, which they all are at the proximal portion of the epididymis to type III, and finally to type I which is ordinarily the predominating type in the semen. Not all are transformed to type I, however; some of types II and III remain untransformed.

The transformation in type is parallelled by a transformation in motility. Type II found in the proximal portion of the epididymis are all nonmotile.

- 3. The relative numbers of the three types is not greatly altered by intensive mating.
- 4. Measurements made of representatives of types I, II, and III, tend to show that these types differ significantly in dimensions from one another. Type II is the smallest, III the largest, and I intermediate.

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# **ILLUSTRATION**

PLATE 1. The three types of spermatozoa formed in the semen of the boar.

175



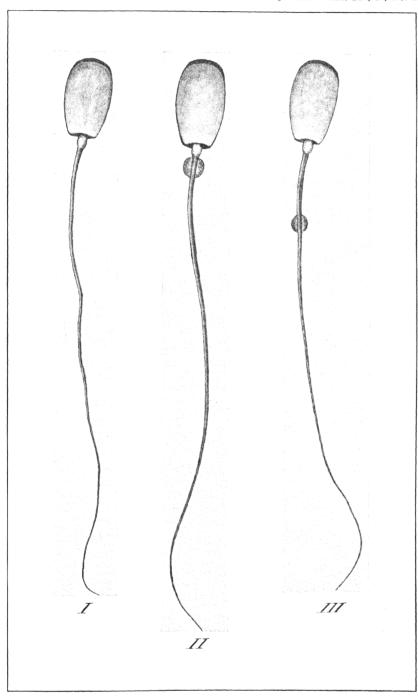


PLATE 1.

# TANNIN CONTENT OF PHILIPPINE BARKS AND WOODS

By Luz Baens, F. M. Yenko, and Augustus P. West

Of the Bureau of Science, Manila

and

# H. M. CURRAN

Of the Bureau of Forestry, Manila

### ONE PLATE

During 1931 the value of the leather and leather articles imported into the Philippines 1 amounted to 2,166,301 pesos. There are a number of tanneries in the Philippines and a considerable amount of leather is produced locally. In most of the tanneries the methods employed for tanning hides are rather antiquated and consequently much of the leather manufactured locally is of poor quality and has a disagreeable odor.

The Philippine methods of tanning and the quality of leather produced could be greatly improved by experimentation. With proper development of the Philippine leather industry it would not be necessary to import considerable quantities of leather. All the leather that is required for local consumption could be manufactured in the Philippines and quite likely an export trade could also be developed.

The first step in the improvement of the leather industry is the investigation of the available local tanning materials in order to determine which materials have the highest tannin content and are most efficient and economical.

In the Philippines the materials commonly used, at present, for tanning hides are the barks of the kamachile tree [Pithecolobium dulce (Roxb.) Benth.] and various species of the mangrove (Rhizophoraceæ or mangrove family). Analyses of Philippine mangrove barks have been made by Bacon and Gana <sup>2</sup> and also by Williams.<sup>3</sup>

<sup>&</sup>lt;sup>1</sup> Annual Report, Insular Collector of Customs, Manila (1933) 194.

<sup>&</sup>lt;sup>2</sup> Philip. Journ. Sci. § A 4 (1909) 205.

<sup>&</sup>lt;sup>8</sup> Philip. Journ. Sci. § A 6 (1911) 45.

In addition to mangrove Gana <sup>4</sup> also analyzed a few other Philippine barks. With the exception of kamachile, these barks gave a rather low percentage of tannin and consequently the results were not promising.

Recently we determined the tannin content of a considerable number of Philippine barks and woods. Some of the barks were high in tannin and appeared to be of commercial value. Most of the woods, however, gave negative tests for tannin, although a few contained a very small amount.

The numerous samples of barks and woods selected for this investigation were taken, in general, from mature trees. Most of the trees were growing on Mount Maquiling near Los Baños in Laguna Province, though some were growing in other provinces.

Preparation of the samples for analysis consisted in first drying them in an oven at  $60^{\circ}$  C., for about twenty hours. The samples were then filed with a rasp and the filings sieved through a 20-mesh screen. The powder which passed through the sieve was used for the analysis.

Moisture determinations were made on the powdered samples and the results of the analyses were calculated on the moisturefree sample.

In analyzing the numerous samples we used a rapid method <sup>5</sup> for the determination of tannin. Results with high tannin barks were, however, checked by the official hide-powder method.

In Table 1 is given the tannin content of a considerable number of Philippine barks. As shown by the data some of them have a high percentage of tannin.

Kamachíle and the mangrove barks (bakáuan laláke, bakáuan babáe, tañgál, potótan, busáin, and lañgarai) are used for tanning and naturally were found to have a considerable amount of tannin.

Samples of other barks (Table 1), which gave a high percentage of tannin, were analyzed by the official hide-powder method in the laboratory of the Philippine Cutch Corporation of Zamboanga through the courtesy of the manager, Mr. Geo. A. Kerr. The results are given in Table 2.

Pieces of hides were tanned very satisfactorily with infusions of these high-tannin barks. These tanning experiments were

<sup>&</sup>lt;sup>4</sup>Philip. Journ. Sci. § A 10 (1915) 355.

<sup>&</sup>lt;sup>5</sup> Baens, L., and A. P. West, Philip. Journ. Sci. 47 (1932) 467.

TABLE 1 .- Tannin content of Philippine barks.

Sample.		Name of bark.	Tannin
No.	Common.	Scientific.	content.
			Per cent
1	Bagtikan	Parashorea malaanonan (Blco.) Merr	3.60
6	Anabióng	Trema orientalis (L.) Bl	17.10
7	Antipólo	Artocarpus blancoi (Elmer) Merr	5.30
8	Balinhásai	Buchanania arborescens Bl	11.10
9	Dúhat	Eugenia cumini (L.) Druce	0.90
10	Kalúmpit	Terminalia edulis Blco	42.00
11	Sakat	Terminalia nitens Presl	27.38
12	Santól	Sandoricum koetjape (Burm. f.) Merr	11.80
13	White lauan	Pentacme contorta (Vid.) Merr. and Rolfe	5.50
14	Bitaog	Calophyllum inophyllum L	19.12
15	Talúto	Pterocymbium tinctorium (Blco.) Merr	10.20
16	Moláve	Vitex parviflora Juss	trace
17	Anonang	Cordia dichotoma Forst. f	1.80
18	Magilik	Premna cumingiana Schauer	none
19	Balákat	Zizyphus talanai (Blco.) Merr	none
20	Aiañgile	Acacia confusa Merr	5.60
21	Agáru	Dysoxylum decandrum (Blco.) Merr	none
22	Abúab	Lophopetalum toxicum Loher	trace
23	Dapdáp	Erythrina variegata L	none
24	Binúñga	Macaranga tanarius (L.) MuellArg	2.10
25	Himbabáo	Allaeanthus luzonicus (Blco.) FVill	trace
26	Liúsin	Parinarium corymbosum (Bl) Miq	6.82
27	Vidal's lanútan	Bombycidendron vidalianum (Naves) Merr. and Rolfe.	none
28	Tuái	Bischofia javanica Bl	trace
29	Sablót	Litsea glutinosa (Lour.) C. B. Rob	0.60
30	Kaliantan	Leea manillensis Walp	11.80
31	Ákle	Albizzia acle (Blco.) Merr	1.80
32	Hauíli	Ficus hauili Blco	none
33	Tíbig	Ficus nota (Blco.) Merr	1.10
34	Malarúhat	Eugenia similis Merr	4.20
35	Lángil	Albizzia lebbeck (L.) Benth	6.50
36	Rosewood	Dalbergia sissoo Roxb	1.00
87	Binúang	Octomeles sumatrana Mig	2.60
38	Guava	Psidium guajava L	11.30
39	Kúpang	Parkia javanica (Lam.) Merr	20.50
40	Mango	Mangifera indica L	9.40
41	Kariskis	Pithecolobium subacutum Benth	21.90
42	Kamachile	Pithecolobium dulce (Roxb.) Benth	30.10
43	Banabá	Lagerstroemia speciosa (L.) Pers	2.20
44	Bayok-bayokan	Pterospermum niveum Vid	9.80
45	Caudate leaf oak	Quercus philippinensis A. DC	7.70
46	Kalamansánai	Neonauclea calycina (Bartl.) Merr	trace
40	Kulatingan	Pterospermum obliquum Blco	19.00
48	Lamóg	Planchonia spectabilis Merr	4.50
48 49	Pagsahiñgin	Canarium villosum (Bl.) FVill	0.20
	Pagsaningin Bakáuan babáe	Rhizophora mucronata Lam	28.50
50	Bakauan lalake	Rhizophora candelaria DC	20.20
51 52	Potótan	Bruguiera sexangula (Lour.) Poir	24.50

Table 1.—Tannin content	of	Philippine	barks—Continued.
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Sample		Name of bark.	Tannin
No.	Common.	Scientific.	content.
56 58 60 63 64 106 107 108 112 113 115	Busáin	Ceriops tagal (Perr.) C. B. Rob	Per cent. 30.70 25.00 27.20 17.80 14.60 none 4.60 1.70 6.30 1.60 11.50 22.50
119 137	Teak Black wattle	Tectona grandis L. f	none 42.50

Table 2 .- Analysis of Philippine tanbarks of high tannin content.

				Solids.	
Bark.	Tannin.	Non- tannin.	Total.	Soluble.	Insolu- ble.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Kalúmpit; Terminalia edulis Blco	34.11	7.23	43.17	41.34	1.83
Sakat; Terminalia nitens Presl	19.46	6.49	28.66	25.95	2.71
Kariskis; Pithecolobium subacutum Benth	19.70	7.63	28.12	27.33	0.79
Kúpang; Parkia javanica (Lam.) Merr	18.07	8.37	27.82	26.44	1.38
Bitaog; Calophyllum inophyllum L	16.05	4.96	22.68	21.01	1.67
Black wattle; Acacia decurrens; thickness of bark:					
1/16 inch	3	10.72	40.16	39.15	1.01
1/4 inch	45.80	10.60	56.80	56.18	0.62
1/4 inch	45.05	10.73	56.58	55.78	0.80
5/16 inch	45.79	10.75	57. <b>2</b> 8	56.54	0.74

a Analysis made under the direction of Mr. Geo. A. Kerr in the laboratory of the Philippine Cutch Corporation of Zamboanga.

carried out in our laboratory and also in the laboratory of the Philippine Cutch Corporation at Zamboanga.

In his report to us Mr. Kerr writes as follows:

The sample of kalúmpit bark (Table 2) contains sufficient tannin to indicate that it may be commercially valuable for the manufacture of tannin extract or for direct use in the tannery. The bark samples of

sakat, kariskis, kúpang, and bitaog may be suitable for direct use in the tannery but the tannin content is not high enough to warrant utilization for making tannin extract.

The black wattle bark gave the highest tannin content (Tables 1 and 2) of all the barks we analyzed. This bark was obtained from trees grown in Bukidnon Province, Mindanao. In the place (sitio) called Kaatoan these trees reached an average height of 5.29 meters in about four years. They were cultivated from seeds that were obtained from the Forest Research Institute, Buitenzorg, Java.

Concerning the analysis and commercial value of the Philippine black wattle bark grown in Bukidnon, Mr. Kerr says:

This bark compares most favorably with the native black wattle bark of Australia and also the plantation bark of Natal and Kenya Colonies, Africa. In fact, the tannin content is considerably higher than the average in those countries and the nontannin content is also good. The color and tannage is about equal to any other bark we have examined. There is no question that, if bark like this could be grown in Bukidnon, there is a very great future for it. Although wattle bark is not used in America to any great extent it is very extensively imported into Europe and Great Britain where, at present, the normal price is from \$35 to \$40 per ton of dry bark.

Mr. Arthur F. Fischer, director of the Philippine Bureau of Forestry, informs us that in some districts in Bukidnon the black wattle tree grows very well and it is quite likely that these trees could be cultivated successfully on rich soil where the climate is similar to that of Bukidnon.

Since 1824 black wattle bark has been used in Australia and Tasmania as tanning material.<sup>6</sup> It was introduced into Natal, South Africa, about 1864. It is now cultivated in other districts in Africa and is considered one of the richest tanning materials known. The bark gives an infusion of good color so that the resulting leather is very light and has only a faint pinkish tinge. Owing to the high proportion of tannin it is a cheap tanning material and the bark can be stored a long time without any appreciable deterioration. Specimens of bark stored in the Sydney Technological Museum for thirty years were analyzed before and after storage. The results showed practically no diminution in the tannin content.

<sup>&</sup>lt;sup>6</sup> Williams, C. O., Union of South Africa, Dept. Agr., Science Bull. No. 106 (1932).

C. O. Williams <sup>7</sup> made a very thorough investigation of the black wattle trees grown in the Wartburg district of Natal, South Africa. These trees gave a fairly good yield of bark. Unfertilized trees (four and a half years old) gave 3.23 tons of green bark per acre while well-fertilized trees gave 5.04 tons.

Black wattle trees (four years old) produced in Natal, Africa, a bark containing 31.5 per cent of tannin, while in the Philippines the bark had 45 per cent. From this it appears that, under favorable growing conditions, black wattle bark gives a higher yield of tannin in the Philippines than in Africa.

The development of Philippine plantations of black wattle trees would seem to offer promising prospects. After stripping the trees of the bark the wood that remains may be used for various purposes. According to C. O. Williams the chief byproduct of the wattle-bark industry in Natal, Africa, is the wood. He estimated that out of the total receipts from an ordinary Natal wattle plantation, about 56 per cent was derived from the sale of the bark, 33 per cent from mine props, and 11 per cent from fuel wood. It is therefore realized that the timber in itself is a valuable source of income as compared with that derived from the bark. He says it would be difficult to find any tanning material that could be produced in South Africa in such quantity and at such low cost as to compete successfully with wattle bark.

In Table 3 is given the percentage of tannin in some Philippine barks obtained from different localities. As shown by the data the tannin content of the bark from trees of the same species grown in different districts varies considerably. In the report of his work on Philippine mangrove barks R. R. Williams states:

It has further been observed that, in general, the tannin content of the bark increases with the size of the tree. It is probable that the age rather than the size of the tree is the true coefficient of the tannin content but since these trees show no seasonal rings of growth it is almost impossible more than roughly to approximate the age.

<sup>&</sup>lt;sup>7</sup> Union of South Africa, Dept. Agr., Science Bull. No. 106 (1932).

<sup>&</sup>lt;sup>8</sup> Union of South Africa, Dept. Agr., Science Bull. No. 106 (1932) 62 and 88.

<sup>&</sup>lt;sup>9</sup> Philip. Journ. Sci. § A 6 (1911) 45.

Table 3.—Tannin content of some Philippine barks from different localities.

Sample		Jame of bark.	Place of collection.	Tannin	
No.	Common.	Scientific.	Place of collection.	content	
				Per cent	
99		Trema orientalis (L.) Bl	Alisongsong Lallo, Cagayan_	23.20	
53	i	do	Tayabas	9.50	
77	}	do	Cabanatuan, Nueva Ecija	10.70	
91		do	Masinloc, Zambales	31.90	
93		do	Subic, Zambales	6.50	
71	1	do	Hermosa, Bataan	10.60	
73	do	do	Limay, Bataan	11.20	
6	do	do	Los Baños, Laguna	17.10	
54	Bakáuan babáe	Rhizophora mucronata Lam _	Tayabas	18.00	
131	do	do	Puerto Princesa, Palawan	11.80	
109	do	do	Palawan	22.50	
55	Bakáuan laláke .	Rhizophora candelaria DC	Tayabas	16.00	
182	do	do	Puerto Princesa, Palawan	9.20	
110		do	Palawan	17.90	
103		Calophyllum inophyllum L	Jurisdiction Lallo, Cagayan.	16.50	
65		do	Pangasinan	16.20	
82	do	do	Vigan Forest Station, Ilo- cos Sur.	5.30	
92	do	do		11.60	
94	do		Masinloc, Zambales	17.30	
121	do	do	Subic, Zambales	9.00	
14	do	do	Limay, Bataan	19.12	
56	Busáin	Bruguiera conjugata (L.)	Los Baños, Laguna Tayabas	30.70	
133	do	Merr.		10.00	
111		do	Puerto Princesa, Palawan	12.60	
66		do	Palawan	19.30	
	Kalúmpit	Terminalia edulis Blco	Pangasinan	16.10	
88	do	do	Vigan Forest Station, Ilo- cos Sur.	22.50	
88	do	do	Bayombong, Nueva Vizcaya	25.90	
62	do	do	Tayabas	24.80	
78	do	do	Cabanatuan, Nueva Ecija	36.20	
95	do	do	Subic, Zambales	32.10	
124	do	do	Masinloc, Zambales	11.40	
72	do	1	Hermosa, Bataan	23.30	
74	do	do	Limay, Bataan	11.70	
10	do	do	Los Baños, Laguna	42.00	
70	Kamachile	Pithecolobium dulce (Roxb.) Benth.	Bucay, Abra	35.20	
67	do	do	Pangasinan	33.00	
89		do	Bayombong, Nueva Vizcaya	30.20	
57	do		Tayabas	25.20	
79	do		Cabanatuan, Nueva Ecija	37.20	
125		do	Masinloc, Zambales	16.00	
96		do	Subic, Zambales	12.20	
122	do		Limay, Bataan	20.40	
42		do	Los Baños, Laguna	30.10	

Table 3.—Tannin content of some Philippine barks from different localities—Continued

Sample	ı	Name of bark.		Tannin
No.	Common.	Scientific.	Place of collection.	content .
104	Kariskis	Pithecolobium subacutum Benth.	Naguilian Lallo, Cagayan	Per cent. 27.70
68	đo	do	Pangasinan	6.80
80	do	do	Cabanatuan, Nueva Ecija	23.50
126	do	do	Masinloc, Zambales	5.20
97	do	do	Subic, Zambales	10.60
41		do	Los Baños, Laguna	21.90
100	Kulatingan		Alisongsong Lallo, Cagayan	16.70
		Bleo.		
86	do	do	Caniaw, Bantay, Ilocos Sur_	28.80
61		do	Tayabas	7.20
75	do	do	Limay, Bataan	27.60
47	do	do	Los Baños, Laguna	19.00
129	Kúpang	Parkia javonica (Lam.)	Mount Banahaw, Tayabas	9.70
		Merr.		
127		do	Masinloc, Zambales	12.70
98	do	do	Subic, Zambales	6.50
123	do	do	Limay, Bataan	21.40
39	do	do	Los Baños, Laguna	20.50
58	Langarai	Bruguiera parviflora (Roxb.) W. and A.	Tayabas	25.00
134	do	do	Puerto Princesa, Palawan	11.50
114	do	do	Palawan	13.10
59	Potótan	Bruguiera sexangula (Lour.) Poir.	Tayabas	20.50
135	do	do	Puerto Princesa, Palawan	18.90
116	do	do	Palawan	18.90
101	Sakat	Terminalia nitens Presl	Alisongsong Lallo, Cagayan.	14.60
102	do	do	Aggutan Gattara, Cagayan_	27.60
69	do	do	Pangasinan	18.70
84	do	do	Vigan Forest Station, Ilo- cos Sur.	9.50
90	do	do	Bayombong, Nueva Vizcaya	44.00
128		do	Masinloc, Zambales	22.00
120		do	Hermosa, Bataan	29.50
130		do	Maligaya Unisan, Tayabas	12.80
81		do	Cabanatuan, Nueva Ecija	21.80
76		do	Limay, Bataan	33.50
11		do	Los Baños, Laguna	27.38
60	Tángal	1	Tayabas	27.20
"		Rob.	•	
136	do	do	Puerto Princesa, Palawan	27.50
118	do	do	Palawan	28.10
110	u			=0.10

In the Wartburg district <sup>10</sup> of Natal, South Africa, the average tannin content of black wattle bark from trees 2 years old

<sup>&</sup>lt;sup>10</sup> Williams, C. O., Union of South Africa, Dept. Agr., Science Bull. No. 106 (1932).

was found to be 26.3 per cent and from trees 12 years old it was 39.8 per cent. Ten years in the age of these trees increased the average tannin content of the bark only 13.5 per cent.

According to our data (Table 3) a bark of a certain species may give a rather high percentage of tannin in one province and a very low percentage in another. Since the barks used for these analyses had about the same thickness this difference in tannin content is too great to be due only to the age of the bark. Apparently the local environmental conditions of tree growth affect considerably the tannin content of the bark.

Our results (Table 3) are interesting for they indicate certain places that are very suitable for growing trees with high-tannin bark. For instance anabióng (sample 91), grown in Masinloc, Zambales, produces bark with a higher-tannin content (31.9 per cent) than when grown in other locations. Anabióng is a fast-growing tree and reaches a diameter of about 10 centimeters in two years. It requires very little labor to obtain the bark as it is easily removed from the tree, and consequently it might be profitable to cultivate anabióng in Zambales.

Kalúmpit bark gave a tannin content of 42 per cent when the trees were grown at Los Baños, Laguna. Sakat bark, grown at Bayombong, Nueva Vizcaya, had 44 per cent of tannin. These barks gave a much lower tannin content when the trees were grown in other districts.

In order to ascertain the most desirable places for growing trees with high-grade tanbark, it would be advisable to cultivate the trees in various locations in the different provinces.

The simplest classification of tannins divides them into two main groups—pyrogallol and catechol tannins. These two classes of tannins may be distinguished by their reactions with certain chemical reagents such as ferric chloride, sulphuric acid, bromine water, and lead acetate with the subsequent addition of acetic acid.

We tested the high-tannin barks for the kind of tannin contained in them. Extracts of black wattle, kariskis, kulatiñgan, bitaog, anabióng, kamachíle, tabígi, and the mangrove barks, gave reactions characteristic of catechol tannins. The dalinsi extract contained pyrogallol tannins. Infusions of kalúmpit, sakat, and kúpang, contained principally pyrogallol tannins, though they also had small amouts of catechol tannins.

A considerable number of Philippine woods were analyzed for their tannin content. Most of the woods gave negative results or only traces of tannin. A few, however, were found to have small amounts of tannin. The names of woods which contained tannin are given in Table 4, and in Table 5 are given the names of those which gave negative results or only traces of tannin.

Sample.	1	Jame of wood.	Tannin
No.	Common.	Scientific.	content.
			Per cent.
19	Lamóg	Planchonia spectabilis Merr	0.50
23	Bingas	Terminalia comintana (Blco.) Merr	1.40
25	Bayók	Pterospermum diversifolium Bl	2.20
33	Palong manok	Alangium chinense (Lour.) Rehder	0.80
43	Apitong	Dipterocarpus grandiflorus Blco	0.30
45	Oak	Quercus bennettii Miq	0.50
53	Kalúmpit	Terminalia edulis Blco	2.90
82	Bitofigol	Flacourtia rucam Zoll. and Merr	1.90
90	Dúñgon-láte	Heritiera littoralis Dry	2.10
92	Tafiğile	Shorea polysperma (Blco.) Merr	1.80
118	Javanese cañafistula	Cassia javanica L	1.20

Table 4.—Tannin content of some Philippine woods.

In addition to our experiments on tanbarks and woods we have also tested some green (unripe) fruits for their tannin content. We found two fruits that seemed to offer promising prospects for making commercial tannin extract. The fruit of sakat (*Terminalia nitens*) gave 29.57 per cent of tannin. Tanning experiments with the extract of this fruit gave about the same results as those obtained with the extract of the fruit of myrobalan (*Terminalia chebula*) which is considered a very good tanning material and contains about 30 to 40 per cent of tannin.

The kernels of some betel nuts <sup>11</sup> gave 26.89 per cent of tannin. The extract from these kernels appeared to be excellent tanning material and gave leather which had a pale cream color. We intend to make tanning tests on the various species of betel nuts and other Philippine fruits when time permits.

We are now preparing to install in the Bureau of Science a miniature tannin extract plant and tannery. We expect to make extracts from the more promising Philippine tanbarks and fruits and to use these extracts for making leather according to the modern technique of tanning. The operation of these plants and the results obtained should be of very practical value to

 $<sup>^{11}</sup>$  Areca catechu L. Varietal determination was not made for lack of botanical material.

Table 5.—Philippine woods which contain no tannin or only traces of tannin.

Sample	Name of wood.								
No.	Common.	Scientific.							
1	Bagtíkan	Parashorea malaanonan (Blco.) Merr.							
7	Bolofigéta	Diospyros pilosantera Blco.							
8	Balakat-gúbat	Sapium luzonicum (Vid.) Merr.							
9	Santól	Sandoricum koetjape (Burm. f.) Merr.							
10	Anúbing	Artocarpus cumingiana Trec.							
11	Balákat	Zizyphus talanai Blco.							
12	Balóbo	Diplodiscus paniculatus Turcz.							
13	Malaikmo	Celtis philippinensis Blco.							
14	Alupág	Euphoria cinerea Radlk.							
15	Banai-bánai	Radermachera pinnata (Blco.) Seem.							
16	Dulit	Canarium multipinnatum Llanos.							
17	Benguet pine	Pinus insularis Endl.							
20	Kayatau	Dysoxylum turczaninowii C. DC.							
21	Kariskis	Pithecolobium subacutum Benth.							
22	Lago	Pygeum vulgare (Koehne) Merr.							
24	Bayánti	Aglaia llanosiana C. DC.							
26	Kulatingan	Pterospermum obliquum Blco.							
27	Bolon	Alphonsea arborea (Blco.) Merr.							
28	Balsa	Ochroma lagopus Schwartz.							
29	Nárra	Pterocarpus indicus Willd.							
80	Ilang-ilang	Canangium odoratum (Lam.) Baill.							
31	Anabióng	Trema orientalis (L.) Bl.							
32	Fire-tree	Delonix regia (Boj.) Raf.							
34	Alím	Melanolepis multiglandulosa (Reinw.) Reichb. f. and Zoll.							
35	Baguilúmbang	Aleurites trisperma Blco.							
36	Gúbas	Endospermum peltatum Merr.							
37	Lúmbang	Aleurites moluccana (L.) Willd.							
38	Malapapáya	Polycias nodosa (Bl.) Seem.							
89	Rain tree	Samanea saman (Jacq.) Merr.							
40	Basikong	Ficus conora King.							
41	Binunga	Macaranga tanarius (L.) MuellArg.							
42	Tibig	Ficus nota (Blco.) Merr.							
44	Gatásan	Garcinia venulosa (Blco.) Choisy.							
46	Camagón	Diospyros discolor Willd.							
47	Tanglin	Adenanthera intermedia Merr.							
48	Tináan-pantái	Cyclostemon bordenii Merr.							
49	Amúgis	Koordersiodendron pinnatum (Blco.) Merr.							
50	Narig	Vatica manggachapoi Blco.							
51	Tuái	Bischofia javanica Bl.							
52	Kalúkoi	Ficus malunuensis Warb.							
54	Tamayuán	Strombosia philippinensis (Baill.) Rolfe.							
	Bayok-bayókan	Pterospermum niveum Vid.							
55	Gisok	Shorea balangeran (Korth.) Dyer.							
56	Salakin	Aphanamixis cumingiana (C. DC.) Harms.							
57	Terukan	Apnanamixis cumingiana (C. DC.) Harms.  Beilschmiedia glomerata Merr.							
58	l i	Beuschmiedia giomerata Merr. Ficus manilensis Warb.							
59	Butli								
60	Bingábing	Macaranga grandifolia (Blco.) Merr.							
61	Sanglai	Ahernia glandulosa Merr.							
62	Hamingdáng	Macaranga bicolor MuellArg.							
63	Ibaibáan	Glochidion philippicum (Cav.) C. B. Rob.							
64	Apanang	Neotrewia cumingii (MuellArg.) Pax and Hoffm.							

Table 5.—Philippine woods which contain no tannin or only traces of tannin-Continued.

Sample		Name of wood.
No.	Common.	Scientific.
65	Pakiling	Ficus odorata (Blco.) Merr.
66	Katong-maching	Chisocheton pentandrus (Blco.) Merr.
67	Iloilo	Aglaia iloilo (Blco.) Merr.
68	Malasangki	Euonymus javanicus Bl.
69	Tañgisang-bayáuak	Ficus variegata Bl.
70	Náto	Palaquium luzoniense (FVill.) Vid.
71	Kamátog	Erythrophloeum densiflorum (Elm.) Merr.
72	Guijo	Shorea guiso (Bleo.) Bl.
73	Mangachapuy	Hopea acuminata Merr.
74	Palosápis	Anisoptera thurifera (Blco.) Bl.
<b>7</b> 5	Raráng	Erythrina subumbrans (Hassk.) Merr.
76	Tambalau	Knema glomerata (Blco.) Merr.
78	Villamil's nato	Sideroxylon villamilii Merr.
79	Pahútan	Mangifera altissima Blco.
80	Bugáuak	Evodia confusa Merr.
81	Tanghau	Astrocalyx calycina (Vid.) Merr.
83	Lanútan	Polyalthia rumphii (Bl.) Merr.
84	Balitahan	Bridelia glauca Bl.
85	Malanángka	Parartocarpus woodii (Merr.) Merr.
86	Almon	Shorea eximia (Miq.) Scheff.
87	White lauan	Pentacme contorta (Vid.) Merr. and Rolfe.
88	Yakál	Hopea plagata (Blco.) Vid.
89	Mayápis	Shorea palosapis (Blco.) Merr.
91	Malúgai	Pometia pinnata Forst.
93	Ákle	Albizzia acle (Blco.) Merr.
94	Bitaog	Calophyllum inophyllum L.
95	Banabá	Lagerstroemia speciosa (L.) Pers.
96	Ceara rubber	Manihot glaziovii MuellArg.
97	Únik	Albizzia chinensis (Osbeck) Merr.
98	fpil	Intsia bijuga (Colebr.) O. Ktze.
99	Indian rosewood	Dalbergia latifolia Roxb.
100	Lanete	Wrightia laniti (Blco.) Merr.
101	Láñgil	Albizzia lebbeck (L.) Benth.
102	Liúsin	Parinarium corymbosum (Bl.) Miq.
103	Moláve	Vitex parviflora Juss.
104	Taiñgang babui	Gonocaryum calleryanum (Baill.) Becc.
105	Pagsahíñgin	Canarium villosum (Bl.) FVill.
106	Pañgi	Pangium edule Reinw.
107	Sibukáu	Caesalpinia sappan L.
108	Talísai	Terminalia catappa L.
109	Tindalo	Paludia romboidea (Blco.) Prain.
110	Aiañgile	Acacia confusa Merr.
111	Teak	Tectona grandis L. f.
112	Kalantás	Toona calantas Merr. and Rolfe.
113	Mahogany	Swietenia mahagoni Jacq.
114	Banúyo	Wallaceodendron celebicum Koord.
115	West Indian cedar	Cedrela odorata L.
116	Vidal's lanútan	Bombycidendron vidalianum (Naves) Merr. and Rolfe.
117	Baringbing	Peltophorum inerme (Roxb.) Llanos.

those interested in the Philippine tanning industry and should serve to improve the quality of leather manufactured locally. Moreover the production of tannin extracts on a small commercial scale may eventually lead to an export trade in this industry.

In their reforestation work the Bureau of Forestry is planning to cultivate in certain districts trees with high-tannin bark.

## SUMMARY

The tannin content of numerous Philippine barks was determined. Kamachile and the mangrove barks (bakáuan babáe, bakáuan laláke, tangal, potótan, busáin, and langarai) are used for tanning and naturally were found to have a considerable amount of tannin.

Other barks which had a rather high percentage of tannin were kalúmpit, sakat, kariskis, kúpang, and bitaog. These barks may be suitable for direct use in the tannery, but, with the exception of kalúmpit, the amount of tannin is not high enough to warrant utilization for making tannin extract.

The black wattle bark gave the highest tannin content of all the barks we analyzed. Bark from trees four years old contained about 45 per cent of tannin. Excellent tannin extract may be made from this bark.

The black wattle tree grows well in Bukidnon and probably it could be cultivated successfully elsewhere in the Islands where the climate is similar to that of Bukidnon. The development of Philippine plantations of black wattle trees would seem to offer promising prospects. After stripping the trees of the bark the wood that remains may be used for various purposes, such as mine timber, fuel, and the manufacture of paper and charcoal.

When trees of the same species are grown in different localities the amount of tannin in the bark may vary a great deal. This difference in tannin content is often too great to be due only to the age of the bark. Apparently the local environmental conditions of tree growth affect considerably the tannin content of the bark. For certain tree species our results (Table 3) suggest some districts that are more suitable than others for producing high-tannin bark.

In order to ascertain the most desirable places for growing trees with high-grade tanbark it would be advisable to cultivate the trees experimentally in various locations in the different provinces.

A considerable number of Philippine woods were tested for tannin. Although a few of these woods contained a small amount of tannin, most of them had no tannin or only traces of it.

We also investigated a few Philippine fruits. Sakat (*Terminalia nitens*) and some betel nuts gave very good tannin extracts.

We are preparing to install in the Bureau of Science a miniature tannin-extract plant and tannery. Extracts obtained from Philippine tanbarks and fruits will be used in making leather.

The Bureau of Forestry is planning to reforest certain districts with trees having bark of high-tannin content.

# ACKNOWLEDGMENT

The authors wish to express their thanks and appreciation to Mr. Geo. A Kerr, manager of the Philippine Cutch Corporation of Zamboanga, for assistance in ascertaining the commercial value of Philippine tanbarks.

To Mr. Mamerto D. Sulit, of the Philippine Bureau of Forestry, obligations are acknowledged for checking the scientific names of the barks and trees recorded in this paper.

# **ILLUSTRATION**

# PLATE 1

Black wattle tree (Acacia decurrens) grown in Bukidnon, Mindanao.
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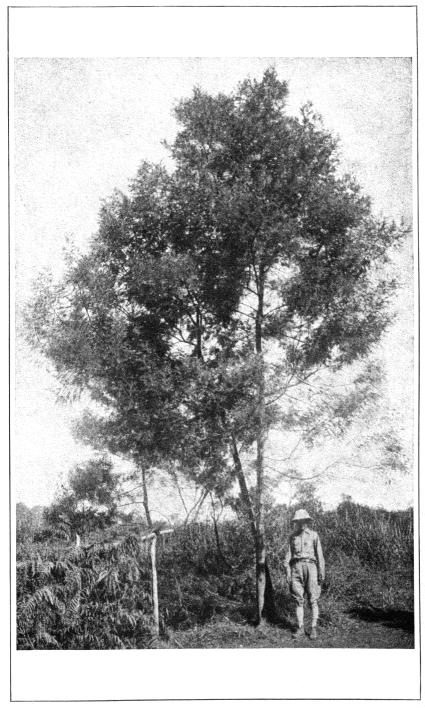


PLATE 1.

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THE PHILIPPINE PHALLOSTETHIDÆ, A DESCRIPTION OF A NEW SPECIES, AND A REPORT ON THE BIOLOGY OF GULAPHALLUS MIRABILIS HERRE.<sup>1</sup>

By Deogracias V. Villadolid and Porfirio R. Manacop
Of the Fish and Game Administration, Bureau of Science, Manila

### FIVE PLATES AND THREE TEXT FIGURES

Herre (1925) erected the genus Gulaphallus (family Phallostethidæ) to accommodate two strange new fishes collected from the fresh-water mountain streams of central Luzon. These are Gulaphallus eximius and G. mirabilis. A year later the same author described another phallostethid, Mirophallus bikolanus, from specimens obtained from the fresh-water lakes of southern Luzon.

The writers now report another species of Phallostethidæ, Gulaphallus amaricola sp. nov., collected from the brackish water <sup>2</sup> about Manila Bay. Of the known species of Phallostethidæ this new form is the first that is not an inhabitant of fresh water. The presence of the spinous dorsal fin and the absence

<sup>1</sup> Data relating to the life history and habits of *Gulaphallus mirabilis* Herre were included in an undergraduate thesis presented for graduation in 1932, by Porfirio R. Manacop, for the degree of Bachelor of Agriculture, prepared in the Department of Entomology, College of Agriculture, University of the Philippines, under the direction of Dr. Deogracias V. Villadolid.

<sup>2</sup> Materials were obtained in two collections from the brackish sloughs near Fort San Antonio Abad, Manila Bay, in the neighborhood of Pasay, Rizal. The first collection was made by Drs. C. G. Manuel and D. V. Villadolid in the summer of 1927, and the second by the former in the summer of 1932.

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of scales on the nape and opercles, place the animal in the genus Gulaphallus.

# GULAPHALLUS AMARICOLA sp. nov. Plate 1, figs. 1, 1a, 2, 2a.

First dorsal, II; second dorsal, I, 4-5 (usually I, 4); anal, I, 14-16 (mostly I, 14). Scales in median lateral series 30 to 32 (counted from gill opening to base of caudal fin); scales from origin of second dorsal to anal, 5; scales from first dorsal to naked region of nape, 17 to 19. Head, nape, and opercle, naked. Dorsal profile slightly elevated, but ventral strongly convex in females.

Myotomes very evident; a fine median dark line on sides extending from upper lid of pectoral fin to caudal base; occiput black. A line of dark chromatophores runs along base of abdominal fringe and anal fin to caudal peduncle. Scales along middorsal line heavily lined with black chromatophores. Scales regularly arranged along lateral line.

Male (Plate 1, figs. 1, 1a).—Body strongly compressed and slender, gradually tapering posteriorly. Sexually mature fish vary from 2.0 to 2.5 centimeters in length. Dorsal fins placed far back, the first above the posterior half of anal, the second originating just above end of anal base. Depth 5.24 in length of body; head with pointed and projecting chin, and 7.24 in length of body; mouth small and nearly vertical, with two rows of fine, pointed teeth in each jaw. Teeth of outer row of upper jaw much larger and more regularly arranged than either the inner row or the teeth of lower jaw. Teeth of outer row of upper jaw become finer towards median line. Interorbital space flat and broader than eye diameter. Pectoral bases muscular; length of caudal fin about 1.5 times its depth. Priapium elongated and projecting slightly downwards. Two priapial appendages present. One of the ctenactinia is so markedly short and small that a casual observer might not notice its presence. It arises from the posterolateral side of the priapium just beneath the greatest curvature of the proximal end of the other, longer priapial appendage. This position makes it appear homologous with the ctenactinium of *Phenacostethus smithi* Myers (1928).

Posterior border of priapium lined with comblike (or finlike) projections which appear similar to those of *Neostethus lankesteri* Regan.

Pulvinulus shieldlike, smaller than eye, facing the side towards which appendages of priapium project. Vas deferens coiled

within posterior end of priapium, opening at tip of a curved end adjacent to the short ctenactinium. This bone, in all likelihood, guides the penislike structure during the act of copulation as in the case of *G. mirabilis*.

Female (Plate 1, figs. 2, 2a).—Similar to male except in the following: (a) Absence of priapial structure, (b) marked convexity of ventral region, (c) two tuftlike papillæ on each side of abdomen just below muscular base of pectoral fin, possibly vestiges of ventral fins. Regions around genital opening elevated; genital opening located ventrally along median line just below base of pectoral fins and posterior to anal opening. A membranous abdominal fringe extends from the groove below genital opening to base of anal fin.

Amaricola, a brackish-water inhabitant.

The above description is based on 127 specimens, 64 males and 63 females, all collected from the sloughs of Manila Bay in the neighborhood of Pasay, Rizal, Philippine Islands.

Types.—One male and one female in the zoölogical museum, College of Agriculture, University of the Philippines. Cotypes are also in the zoölogical museum.

 $Type\ locality.$ —Pasay, Rizal Province, Luzon Island, Philippine Islands.

On the average, *G. amaricola* is smaller than the other species of the Philippine phallostethids. Sexually mature specimens measure only 2.16 centimeters in length.

The taxonomic characters that justify the separation of *Gula-phallus amaricola* from the other known species of the genus are shown in the following table.

Characters.	G. amaricola.	G. mirabilis.	G. eximius.
Second dorsal	I, 4 (rarely I, 5)	I, 6	I, 6.
Anal	I, 14-16	I, 16 or 17	I, 14-16.
Pulvinulus	Present	Absent	Absent.
Scales in longitudinal series	30-32	36-38	56-58.
Scales, origin of 2d dorsal to hind end of anal.	5	9	14.
Predorsal scales	17-19	26	28.
Comblike projections at base of priapium.	Present		Absent.
Priapial appendage	Two ctenactinia, one very short, almost vestigial and pin- like.	Two ctenactinia, one slightly shorter and clawlike.	Two ctenactinia, one slightly shorter and hook- like but broad.

The number of scales in a lateral series in *G. mirabilis* was reported by Herre to be 36 to 38 from the type locality (Mount Ibo Creek, Bulacan). Our count from specimens collected from Molawin Creek, Laguna, showed, however, that the range was 32 to 35. This apparently overlaps to a slight extent the range of scales of *G. amaricola*, which is 30 to 32. However, *G. amaricola* cannot be identical with *G. mirabilis* of Molawin Creek because of the differences shown in the key below, and from the difference in the number of scales as follows:

	G. mirabilis.	G. amaricola.
Origin of 2d dorsal to end of anal	7	5
Origin of 2d dorsal to origin of anal	12	10
First dorsal to head	27-29	17-19

### THE PHILIPPINE PHALLOSTETHIDÆ

The family Phallostethidæ comprises a group of fishes unique among the entire vertebrate fraternity. So far they are the only vertebrates which present structures not recognized until the discovery in 1913 by C. Tate Regan of one of its members. Phallostethus dunckeri from Johore, Malay Peninsula. (1928) describes the unique characteristics of the Phallostethidæ as follows: "Pelvic fins reported as vestigial in the female and absent in the male, whilst below the head and throat of the latter was a most peculiar appendage containing the coiled vas deferens and the end of the intestine, together with a complicated skeletal system mostly of what appeared to be entirely new ele-This appendage, called by Regan the priapium, bore externally two long curved bones apparently used as clasping organs. These are the toxactinium and ctenactinium of his (Regan's) descriptions."

Dr. Carl L. Hubbs, in a letter to the senior author dated June 16, 1931, expressed the opinion that it is possible that the family Phallostethidæ to which *Gulaphallus mirabilis* Herre belongs is phylogenetically more nearly related to Percesoces than to Cyprinodontes. In the latter order the family Phallostethidæ is generally included. He says in part: "... A point that struck my attention was the mention that you had found that the eggs were attached by long filaments. This discovery confirms, though it can hardly be said to prove, Myers's contention that the Phallostethidæ are derivatives of the Percesoces rather than of the Cyprinodontes which lack egg filaments. Such filaments are developed in all Atherinidæ, so far as known, except in *Leuresthes*."

To date the known Philippine representatives of Phallostethidæ are only four and may be identified by the use of the following artificial key:

- a 1. Spinous dorsal present; nape and opercles naked.
  - b. Comblike projections from base of priapium present (in males). Inhabitant of brackish-water. Scales 30 to 32 in lateral series.

Gulaphallus amaricola sp. nov.

- b. Comblike projections from base of priapium (in males) absent. Inhabitant of fresh-water streams.
  - $c^1$ . Scales 56 to 58 in lateral series....... Gulaphallus eximius Herre.  $c^2$ . Scales 36 to 38 lateral series......... Gulaphallus mirabilis Herre.
- a<sup>2</sup>. No spinous dorsal; nape and opercles scaly; scales 32 in lateral series. Inhabitant of fresh-water lakes............ Mirophallus bikolanus Herre.

Distribution of Philippine phallostethids.—With the exception of G. amaricola sp. nov. all the known members of the family Phallostethidæ are inhabitants of fresh-water bodies; G. amaricola is an inhabitant of the brackish water of the sloughs about Manila Bay.

Gulaphallus mirabilis Herre was originally reported and described from Ibo Creek, a tributary of Angat River, Bulacan Province, Luzon. This river empties into Manila Bay. This species is also found in large numbers in Molawin Creek, Laguna, which originates in Mount Maquiling, and, like Angat River, empties into Manila Bay, through Laguna de Bay and Pasig River.

Gulaphallus eximius Herre was originally described from specimens collected from a mountain stream at Santa Fe, Nueva Vizcaya Province, Luzon. This stream is a branch of Magat River emptying into the main stream, Cagayan River, which in turn empties into the open sea in the northern part of Luzon.

Mirophallus bikolanus Herre was described from specimens collected from Lake Bato, Camarines Sur, and from Lake Lanigay, Albay. Both of these provinces are in the southern part of Luzon. Both Lake Bato and Lake Lanigay are connected with tributaries of Bicol River which empties into San Miguel Bay of the China Sea.

Distribution of Gulaphallus mirabilis in Molawin Creek.—Surveys April 7 and 8, 1931, along Molawin Creek, showed that the fish occurred from within a kilometer from the mouth up to an elevation of about 70 meters. The absence of Gulaphallus beyond this altitude may be due to the presence in that part of the creek of a waterfall which is about 3 meters high. The absence of Gulaphallus at the mouth of Molawin Creek was due

probably to the water being shallow. The depth of the water was found to be about 30 centimeters, and the fish apparently avoids very shallow water. Observations on the habitat of *Gulaphallus* in Molawin Creek showed that they prefer deep, shaded, and quiet places. Another survey of the creek was made November 22, 1931, when the water of Laguna de Bay was at high tide. *Gulaphallus* was found at the mouth of the creek. The water at that time was about 1.5 meters deep.

It is not improbable that some of the *Gulaphallus* may be carried into Laguna de Bay by floods. Nevertheless, a great number apparently manage to remain in the creek, as shown by the fact that just after a flood collections made in the creek still yielded plenty of specimens. The fish probably take refuge in back eddies where the current is not strong enough to carry them along during the flood.

# BREEDING HABITS

(a) Manner of oviposition.—Observations on the breeding habits of G. mirabilis were made in a glass aquarium of about 30 liters capacity, in which Ceratophyllum demersum Linnæus was kept. The bottom of the aquarium was covered with a thin layer of sand and gravel from Molawin Creek.

Four females carrying ripe eggs and two adult males were transferred into the aquarium. September 15, 1931, at about 8 a. m., one of the four females was observed swimming up and down the aquarium. Soon two to three eggs were seen arranged in a linear series in its oviduct. After a few minutes the fish was observed swimming slowly in a dorsolateral position, and then it rested close to a healthy stem of Ceratophyllum. This was followed by the vibration of the caudal half of the body and the subsequent jerky motion of the whole body followed by the extrusion of the eggs. As soon as each egg was extruded it attached itself automatically to the leaves or stems of Ceratophyllum by its adhesive threadlike processes. The eggs apparently did not receive parental care after oviposition.

(b) Copulation (Plate 5, fig. 2).—Five mature females and three mature males were placed in a balanced aquarium in the laboratory. Copulation was observed to occur at any time of the day throughout the breeding season.

Prior to copulation, the male usually darts around a female and snappily grips her with its toxactinium. When the male fails to grasp the female, he chases her. Sometimes he is interrupted

Table 1.—The average monthly diameter frequencies of ova of Gulaphallus during the spawning period. (Ova were taken from ten fishes at intervals of fourteen days.)

					E	iamete	r freque	ncy.				
Egg diameter.	19	30		1931								
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct
mm.												
0.025-0.07	19	24	23	23	30	30	34	33	38	23	16	26
.07108	73	62	61	69	62	72	85	73	62	79	65	67
.08109	29	28	25	24	14	11	8	12	14	10	9	28
.09110	13	18	20	21	19	18	12	26	22	28	35	26
.10111	11	19	18	14	12	9	8	11	12	26	23	23
.11112	15	14	20	14	15	19	15	19	12	14	19	24
.12113	14	12	15	13	12	12	9	17	15	6	15	22
.13114	9	10	13	16	16	6	13	14	8	5	9	10
.14115	13	12	11	12	14	12	11	9	11	9	6	8
.15116	9	8	9	7	14	9	7	0	7	5	2	3
.16117	8	9	7	8	6	8	7	2	5	4	3	4
.17118	7	8	6	10	7	10	3	0	7	4	8	3
.181~ .19	12	7	7	9	10	7	9	9	8	8	9	0
.19124	9	10	4	9	8	9	5	11	9	7	10	3
.24129	6	8	10	8	9	7	11	4	8	6	8	2
. 291 34	10	10	8	6	10	12	8	10	8	5	4	4
. 341 39	10	8	9	7	9	11	7	8	8	8	8	2
. 391 44	9	5	8	5	7	8	8	13	11	10	11	8
.44149	6	8	6	5	6	8	7	1	9	14	8	6
.491~ .54	4	5	4	3	4	3	5	2	5	6	6	7
. 541 59	5	3	2	3	4	2	3	1	4	6	7	5
.59164	3	2	3	2	1	2	5	o	2	3	4	4
.64169	1	1	1	2	1	3	4	3	3	2	3	3
.69174	1	0	0	2	0	2	3	5	2	3	2	2
.74179	0	0	1	0	2	4	8	5	1	3	4	1
.79184	0	1	1	0	2	2	1	4	0	1	0	3
.84189	2	3	2	1	0	0	0	0	1	0	0	0
. 891 94	0	1	1	3	1	0	1	4	1	2	2	0
. 941 99	2	1	2	2	2	2	3	2	2	1	1	4
. 991–1 . 04	2	3	3	2	3	2	5	2	5	2	3	2
Total_	300	300	300	300	300	300	300	300	300	300	300	300

by a rival. It was observed that the victorious male drives away the vanquished. Some females were observed to approach males or swim around them at the time trying to flash their silvery white bellies. This behavior of the female probably attracts the males during the breeding season when the female is laden with ripe eggs. Newman (1906–1907) observed a similar behavior in *Fundulus majalis* Linnæus, where the females laden with ripe eggs frequently displayed themselves by

turning on the sides of the males near the bottom, spurning them with their tails, and causing their silvery white bellies to flash in the light.

During copulation the female *Gulaphallus mirabilis* lies on the aproctal side (either left or right) of her mate, depending upon the position of the toxactinium of the male. The toxactinium which curves toward the aproctal side grips the female under the chin and across the back part of the head, while the ctenactinium takes a firm hold on the pectoral region in front and on the side of the genital orifice until the penislike structure is introduced into the orifice.

While in this position, the pair swims about the aquarium. It may be assumed that during this time the sperm is discharged into the oviduct. The discharge of the sperm into the oviduct and its storage there are shown by the presence of active sperm in this region of a female that has just undergone copulation. Thus copulation in *Gulaphallus mirabilis* is apparently intromittent. The eggs are probably fertilized as they pass out through the oviduct, as may be judged from the fact that freshly extruded eggs when cultured in water free from sperm have been found to develop and hatch.

Copulation was observed in the aquarium to last for from one to two minutes. Copulating pairs have been observed to seperate at once when disturbed by the other fishes. Sometimes the female struggled as if trying to separate from her mate.

# SPAWNING SEASON

- (a) Condition of the ovary during the spawning season.—A spawning female has three classes of eggs in the ovary. These are:
- 1. The immature eggs (group I) (Plate 2, fig. 1) measure from 25  $\mu$  to 129  $\mu$  in diameter. This group is represented by the largest number of eggs, the mode of which was found to be 0.07 millimeter for the three groups of eggs. This group is very transparent and appears slightly creamy when preserved in 10 per cent formalin solution, and is not visible to the naked eye. This kind of eggs is present in sexually mature females at all times throughout the year.
- 2. The intermediate eggs (group II) (Plate 2, fig. 2) measure from 130  $\mu$  to 410  $\mu$  in diameter. The eggs are creamy white and opaque with threadlike processes wound tightly around them in a labyrinthine manner. The presence of this class of eggs

in a female may be regarded as an indication of approaching maturity.

The immature and intermediate classes of eggs were readily separated from the maturing ova (group III) as the immature and intermediate classes were still bound together by the connective tissue of the ovary, while the maturing eggs (group III) were either free or loosely attached by the same tissue.

3. The maturing eggs (group III) (Plate 2, fig. 3) measure from 0.411 to 1.03 millimeters in diameter. The eggs are orange, translucent rather than opaque, and the threadlike processes have loosened up. When the size limit of about 1 millimeter is reached, the egg is expelled and deposited.

The ovary of the spawning female during the spawning season is very much distended, occupying almost one-fourth of the abdominal cavity (Plate 3, fig. 3). During the spawning period, however, some adult females were found with only immature and intermediate groups of eggs. This indicates that either the fish had not yet developed the maturing eggs or the maturing group of eggs has just been spawned.

(b) Time of spawning.—The spawning season was determined by collection and measurement of ova at intervals of fourteen days from November, 1930, to October, 1931. It was found that the fish spawns throughout the year, as spawning individuals could be found at all times during the year (fig. 1). During the course of this study mature eggs could be secured at any time for embryological study.

Fig. 1 is a summary of diameter frequencies of ova measured at intervals of fourteen days. Each curve represents the average of two measurements a month of 300 ova taken from ten fishes selected at random at each inspection.

The frequency curves in fig. 1 further lead to the following interpretations: (a) The rate at which the intermediate class of ova are derived from the immature group by the process of development and growth is slow and gradual. (b) This is also true within the transformation of the intermediate class into the maturing class of ova. This assumption is reënforced by the fact that spawning females have been repeatedly observed to contain only a few maturing ova at a time, the number varying from five to thirty, depending upon the size of the female. The sudden drop in fig. 1 of the frequency curves from the mode confirms the foregoing conclusions. With the exception of a few small, and probably insignificant, fluctuations, the remainder of

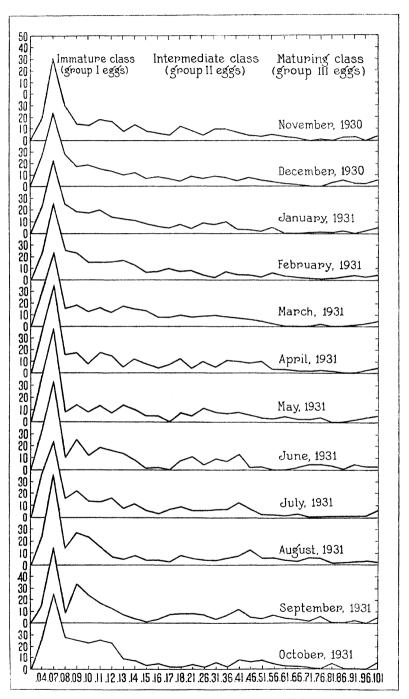


Fig. 1. Diameter frequencies of ova during the spawning season, Molawin Creek, November, 1930, to October, 1931. (Based on Table 1.)

the curve from the base of the mode, beginning with 0.09 millimeter and ending at 1.01 millimeters, represents a markedly gradual slope. Eggs about 1 millimeter in diameter are ready to be expelled.

(c) Peak of spawning activity.—Examination of mature females was made at intervals of fourteen days throughout the year. The percentage of spawning fish for each examination was computed. Table 5 shows that the greatest number of spawning fish was found in the samples collected during December, with a percentage of 58.67, and January, with 80.45 per cent. Greater spawning activity during January may be further indicated by the presence of larvæ of Gulaphallus in the stomachs of its own kind during that month. One year's examination of the stomach contents of both the immature and mature Gulaphallus shows that only during the month of January larvæ of this fish represented food of the same fish.

As may be expected, the least number of spawning Gulaphallus was found during May and June (Table 5). These conclusions, however, must be considered as tentative in view of the fact that sampling was done only twice a month. Our results to date, nevertheless, seem to show that the spawning season of G. mirabilis continues throughout the entire year.

# FOOD AND FEEDING HABITS OF GULAPHALLUS

Thirty mature and thirty immature fish were collected, dissected, and examined every month. Tables 2 and 3 and figs. 2 and 3 show the results of the examination of the food of the fish. It may be seen that both the immature and the mature fish subsist upon practically similar kinds of food, the difference being merely in quantity.

- (a) Vegetable matter.—Vegetable matter was found in the stomachs of both to the amount of  $8.69 \pm 0.978$  per cent of the total bulk of food consumed by the mature and  $13.01 \pm 0.782$  per cent by the immature. The difference of  $4.319 \pm 1.121$  between the amount of vegetable matter consumed by the mature and by the immature fish is significant in indicating that as the fish become older they subsist very largely on animal matter. This food was found to be taken by both throughout the year, that is, from September, 1930, to August, 1931.
- (b) Chironomid larvæ and pupæ.—These items rank first in importance among the food of the fish. They form  $33.39 \pm$

2.38 per cent for the immature and  $38.35\pm2.02$  per cent for the mature fish of the total bulk of food consumed. This animal food, like the vegetable matter, is taken by the fish as part of its diet throughout the year. The difference of  $4.96\pm3.12$ 

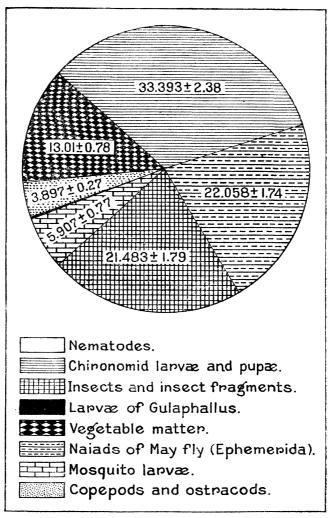


Fig. 2. Yearly proportions of food items consumed by the immature Gulaphallus.

per cent in the amount of these items consumed by the immature and mature groups is not significant.

(c) Insects and insect fragments.—Among the insects that were found occasionally in the stomachs of the mature fish were water beetles and adult mosquitoes. On the other hand, water

beetles, termites, and ants were found in the stomachs of the immature group. In each group, insects and insect fragments were represented in the diet throughout the year.

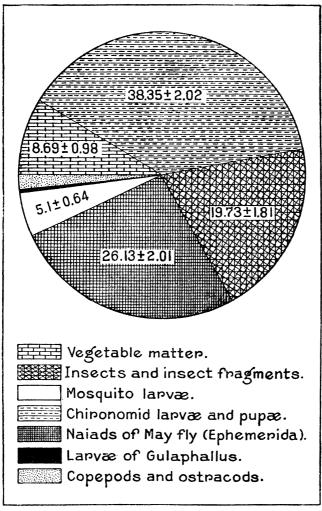


Fig. 3. Yearly proportions of food items consumed by the mature Gulaphallus.

Of the total bulk of food taken, the mature group consumed  $19.73 \pm 1.81$  per cent and the immature,  $21.48 \pm 1.79$  per cent. The difference of  $1.75 \pm 2.1$  per cent, however, in the amount consumed by the two groups of fish was found to be of no significance.

TABLE 2.—The monthly range of food of immature Gulaphallus.

Food.	Sept.	Oct.	Now.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Average.
	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Vegetable matter	7.21	9.00	18.45	10.66	19.50	15.50	15.53	17.13	12.21	8.43	10.42	12.00	$13.008\pm0.782$
Chironomid larvæ and pupæ	56.07	35.00	48.85	23.38	23.75	25.86	16.92	29.15	20.36	36.37	44.64	40.36	$33.898 \pm 2.381$
Insects and insect fragments	5.98	15.12	20.17	36.00	34.09	30.33	20.13	18.77	25.91	26.08	10.89	14.33	$21.483\pm1.794$
Naiads of May flies (Epheme-	20.84	27.80	4.03	21.30	13.61	20.02	34.50	20.26	36.37	14.71	26.92	24.31	$22.058 \pm 1.740$
rida).					academic shiftin				and the second				
Mosquito larvæ	6.22	10.80	5.47	4.50	3.30	2.21	8.27	8.46	2.89	9.34	3.42	00.9	$5.907\pm0.172$
Larvæ of Gulaphallus	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1	1 1 1	1	2.05	1				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1	1	$0.171\pm0.118$
Copepods and ostracods	3.68	2.28	2.03	4.16	3.70	6.05	4.65	6.23	2.20	5.07	3.71	3.00	$8.897 \pm 0.270$
Nematodes			1.00	1 1 1	1 1 1	1	1		1	1		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	$0.083 \pm 0.053$
Total	100.00	100.00	100.00	100.00 100.00 100.00 100.00 100.00 100.00	100.00	100.00	100.00	100.00	100.00	100.00 100.00 100.00	100.00	100.00	100.00

TABLE 3.—The monthly range of food of mature Gulaphallus.

. Average.	P. ct. 8.689±0.978 28.831±2.017 4 19.732±1.808 5 26.132±2.010	6 5.100±0.641 0.292±0.619 2 1.705±0.285	0 100.00
Aug.	P. ct. 8.21 48.92 12.14 26.65	3.36	100.0
July.	P. ct. 3.05 56.11 5.72 28.44	6.02	100.00
May. June. July.	P. ct. 3.53 34.14 26.17 28.23	3.84	100.00
May.	P. ct. 10.43 27.69 19.00 40.23	6.13     1.59     4.09     6.02     3.36       8.20     1.06     8.84     0.66     0.72	100.00
Apr.	P. ct. 8.33 50.55 13.33 19.46	5.13	100.00
Mar.	P. ct. 9.07 25.48 29.47 25.75	5.06	100.00
Feb.	P. ct. 5.83 49.15 14.49 23.53	5.79	100.00
Jan.	P. ct. 18.50 27.26 19.50 29.00		100.00 100.00 100.00 100.00 100.00 100.00 100.00 100.00 100.00 100.00 100.00 100.00 100.00
Dec.	P. ct. 12.66 32.69 31.67 19.67	2.41	100.00
Nov.	P. ct. 16.25 37.25 34.30 2.00	3.94 9.86 2.41 1.06 0.94 0.90	100.00
Oct.	P. ct. 5.41 38.33 8.32 42.94	3.94	100.00
Sept.	P. ct. 3.00 32.66 22.66 27.68	12.98	100.00
Food.	Vegetable matter	Mosquito larvæ	Total

- (d) Naiads of May flies (Ephemerida).—The mature group consumed  $26.13 \pm 2.01$  per cent and the immature  $22.06 \pm 1.74$  per cent of the total bulk of food taken. Like the three foregoing items, naiads of May flies were represented in the stomachs of both groups of fish throughout the year. The difference of  $4.074 \pm 2.6$  in the amount of these items consumed by the mature and immature groups is not significant.
- (e) Mosquito larvæ.—These items were represented in the stomachs of both the mature and immature fish to the amount of  $5.10\pm0.641$  per cent of the total bulk of food consumed for the mature and  $5.91\pm0.172$  per cent for the immature. The difference of  $0.81\pm0.67$  is not significant.
- (f) Larvæ of Gulaphallus.—Outside the month of January, the larvæ of the fish were never represented in the monthly range of food of each group of fish. This food item formed 3.5 per cent of the total amount of food consumed for that month for the mature group and 2.05 per cent for the immature.

The larvæ of the fish as a part of its diet represent only  $0.292\pm0.62$  per cent of the total bulk of food consumed for the mature and  $0.171\pm0.113$  per cent for the immature. The difference of  $0.121\pm0.61$  per cent in the total bulk of this item is not significant.

- (g) Copepods and ostracods.—These crustaceans formed the least of the minor food of the fish. They formed only 3.90  $\pm$  0.270 per cent of the total bulk of food consumed for the immature and  $1.74\pm0.285$  for the mature. These items were also found in the stomachs of both groups of fish throughout the year. The difference of  $2.192\pm0.0391$  per cent was found to be significant.
- (h) Nematodes.—These formed only  $0.083 \pm 0.053$  per cent of the total bulk of food consumed by the immature group. This item was found to be taken only in the month of November when it formed 1.00 per cent of the amount of food consumed for that month. It was not found in the stomachs of the mature fish. There is a possibility that these animals were parasitic in the alimentary tract of the young fish.

From the foregoing results of the feeding habits of *Gulaphallus* the following conclusions may be deduced:

- 1. It is apparent that both groups of fish are more insectivorous than herbivorous.
- 2. Chironomid larvæ and pupæ, naiads of May flies (Ephemerida), and insects and insect fragments, form the major

portions of the animal food of both the mature and immature groups.

- 3. Mosquito larvæ, vegetable food materials, and crustaceans (copepods and ostracods) form minor foods of both.
- 4. Larvæ of *Gulaphallus* were taken by both groups of fish only during January. This apparently shows that the fish became accidental cannibals only during this month, when the peak of spawning activity was found to occur.
- 5. The essential difference between the food of the immature and mature fish is only in the amount of vegetable materials and crustacean food (copepods and ostracods) eaten. It is evident that the immature group took more vegetable food materials and crustacean food than the mature group. The immature fish appears to become insectivorous as it grows older. No indication, however, could be found that the mature fish at any stage prefers a particular kind of insect food.

### EMBRYOLOGY OF GULAPHALLUS MIRABILIS

(a) The newly laid eggs (Plate 2, fig. 4).—These are highly transparent, spherical, with a diameter of about 1 millimeter. They are demersal eggs held by a tangle of adhesive threadlike processes (Plate 2, fig. 4, at), which arise from the different parts of the egg membrane. These adhesive processes attach the egg to any object in the spawning ground. It seems, however, that plants are preferred to stones and decaying wood as sites for oviposition.

The yolk sphere contains 70 to 80 oil globules of unequal size. Numerous tiny globules are also scattered through the cytoplasmic mass. Newly laid eggs that are presumably fertilized remain highly transparent up to one hour or more after laying.

- (b) Incubation period.—Under laboratory conditions the period of incubation during the months covered by the experiment lasts from eight to eleven days with an average of  $9.50\pm0.079$  days (Table 4). The eggs were hatched in Petri dishes containing tap water which was changed daily up to the time of hatching.
- (c) Embryology (Plate 2, figs. 4 to 22).—Observations on the embryonic development were made exclusively on living materials. Newly laid eggs placed in Petri dishes half filled with tap water were used in this study.

Lot No.	Eggs laid.	Eggs hatched.	Incubation period.
	1930	1930	Days.
I	11-XI	22-XI	11
II	17-XI	27-XI	10
III	22-XI	30-X1	8
IV.	28-XI	8-XII	10
V	6-XII	15-XII	9
	1931	1931	
VI	26-I	4-II	9
VII.	31-I	11- <b>II</b>	11
VIII.	6-II	15-II	9
IX	6-II	16-II	10
X	8-II	16-II	8
Maximum			11
Minimum.			8

TABLE 4.—The incubation period of eggs of Gulaphallus under laboratory conditions (submerged in water).

(d) Early cleavage to formation of blastodisc.—The newly laid eggs have a relatively narrow perivitelline space. This space apparently becomes wider about one hour or more after laying. The blastodisc (Plate 2, fig. 5, bd) becomes well differentiated about one hour after laying, appearing as a lenticular protrusion of protoplasm at one pole of the yolk sphere. As differentiation of the blastodisc proceeds, the oil globules collect at one pole of the yolk sphere, usually opposite the blastodisc.

First cleavage occurs about two hours after laying. The blastodisc divides into two approximately equal daughter cells (Plate 2, fig. 6). About three hours after laying, the second plane of cleavage appears, cutting the first at right angles and dividing the blastodisc into four approximately equal daughter cells (Plate 2, fig. 7).

The blastodisc with eight cells possesses distinct bilateral symmetry (Plate 2, fig. 8). After this stage, however, cell division becomes irregular, the bilateral arrangement of the constituent cells disappears, and cells of variable size are produced. A blastodisc about six hours old (Plate 2, fig. 10) appears somewhat dome-shaped with the periblast and periblastic nuclei (Plate 2, fig. 10, pb) becoming apparent around its periphery. The per-

TABLE	5.—The	monthly	percentag	ie <b>o</b> f	mature	egg.	-bearing	Gu <b>lapha</b> llus
fr	om samp	les collect	ed at 14-0	lay ir	itervals	from	Molawin	Creek.

Date.	Fish exam- ined.		th mature ggs.	Average for the month.
1930			P. ct.	P. ct.
15-XI	50	16	32.00	33.31
29-XI	52	18	34.62	
13-XII	51	34	66.67	58.67
27-XII	56	28	50.00	1
1931				
10-I	54	48	88.89	80.45
24-I	50	36	72.00	, 00.10
7-II.	55	20	36.36	40.73
21-II	51	23	45.10	]
7–III	56	27	48.21	40.77
21-III	60	20	33.33	10.11
4-IV	62	20	32.26	34.31
18-IV	66	24	36.36	} 01.01
2-V	58	19	32.76	27.49
16-V	54	12	22.22	} 21.40
30-V	40	8	20.00	1
13-VI	45	13	28.88	29.31
27-VI	51	20	39.22	
11-VII	55	30	54.54	43.94
25-VII	48	16	33.38	40.54
8-VIII	45	14	31.11	31.11
22-VIII				31.11
5-IX	50	14	28.00	32.75
19-IX	56	21	37.50	34.15
3-X	40	18	45.00	1
17-X	56	28	50.00	47.29
31-X	64	30	46.88	

iblastic nuclei are doubtless derived from the peripheral cells of the blastoderm and the periblast is believed to have something to do with the assimilation of the yolk by the developing embryo.

The blastoderm continues to increase in diameter and ultimately spreads over the entire surface of the yolk. In embryos nine hours old, the blastoderm covers about one-half of the surface of the yolk (Plate 2, fig. 11).

(e) Formation of the primitive streak and early embryonic stages.—The cell layers at the edge of the blastoderm thicken about twenty hours after hatching. This thickened region is the germ ring (Plate 2, fig. 12, gr). The subgerminal cavity (Plate 2, fig. 12, sg) becomes evident also at this time by the thinning of the central area of the blastoderm.

Before the germ ring is fully differentiated, however, a thickening becomes apparent at the posterior or embryonic pole of the blastoderm (Plate 2, fig. 12, es). This is the embryonic shield, a broad tongue of cells which grows forward (Plate 2, fig. 12, es). The embryonic shield grows larger and becomes more definitely outlined. About eight hours after the formation of the germ ring there occurs a linear thickening along its anteroposterior axis. This linear thickening is the primitive streak (Plate 2, fig. 13, ps), with the prospective head of the animal at its tip.

On the lateral sides of this, the lens and optic vesicles become apparent about thirty-six hours after oviposition. At this time also, five to seven somites are in evidence (Plate 2, fig. 14, sm). The oil globules are now grouped together at about the caudal end of the embryo. About twelve hours later, the eyes become prominent and from 14 to 16 somites are fully developed, (Plate 2, fig. 15). The oil globules are now diffusely scattered in the yolk mass. The metameric segments increase in number with the age of the embryo.

(f) Later embryonic stages.—Sixty-two hours after laying pigmentation begins to develop. The black pigments first appear as rounded dots scattered over the dorsal and lateral aspects of the head. Early embryonic circulation also becomes manifest at this time. The heart (Plate 2, fig. 16, h) is very distinct. The membranous fold which extends from the middorsal region around the caudal end and along the ventral side of the embryo, is already differentiated (Plate 2, fig. 16, mf). The embryo now covers about two-thirds of the surface of the yolk sphere.

About twenty-six hours later, the punctiform black pigments develop into pigmented processes which are scattered from the dorso-medial aspect of the head up to the anterior portion of the trunk region (Plate 2, fig. 17).

The formative pectoral fins are observed in embryos about one hundred two hours after laying. They appear as more or less triangular protrusions arising laterally at about the neck region (Plate 2, fig. 18, pa). The black chromatophores increase in number and size on the dorsal aspect of the head, pectoral region, and extra-embryonic area.

The embryo has grown considerably in length and has completely extended around the circumference of the yolk sphere by about one hundred twenty-six hours after laying. The for-

mative pectoral fins are also considerably elongated. The black chromatophores have increased further in number on the dorsal aspect of the head, the anterior region of the trunk, and along the lateral and dorsal sides of the body (Plate 2, fig. 19). About thirty-four hours later, the formative pectoral fins become differentiated into pectoral fins (Plate 2, fig. 20). The black chromatophores become aggregated on the top of the head.

About three hours before hatching, the embryo has grown considerably in size (Plate 2, fig. 21). The head is very much enlarged and occupies almost one-third of the egg. The yolk is materially reduced, and the larva is observed wiggling furiously at about this time.

The larva is liberated about two hundred and eleven hours after laying. It is very active soon after its escape from the egg membrane. The black chromatophores are now arranged in series along the dorsal aspect of the head.

The exact cause of the rupture of the egg membrane could not be determined. It was assumed, however, that the rupture was due to the wiggling action of the larva.

# POSTEMBRYONIC DEVELOPMENT, WITH SPECIAL REFERENCE TO THE DEVELOPMENT OF THE MALE COPULATORY ORGANS

In the study of the development and position of the male copulatory organs of *Gulaphallus*, newly hatched fish reared in glass aquaria were used. The work was carried on for three and one-half months, from June 15 to October 31, 1931. Observations were made at intervals of seven days on twenty newly hatched larvæ.

(a) The newly hatched larva (Plate 2, fig. 22).—Newly hatched larvæ measure about 4 millimeters in length. The head is somewhat enlarged and flattened ventrally and convex dorsally; the eyes are large and slightly elliptical; the body is transparent, slender, and slightly tapering posteriorly. Black chromatophores are visible from the dorsal aspect of the head and along the dorsal and lateral sides of the body up to the caudal region.

The yolk sac which appears as an orange semiovoid structure is located on the ventral side, a little posterior to the head region. Resorption of the yolk is complete about two or three days after hatching. The pectoral fins, aided by the vibratory movement of the caudal region, are used as the primary propellers of the body for swimming.

The mid-dorsal region gives rise to a low median fold which continues to form around the caudal end and subsequently extends its formation along the ventral side, ending at the posterior border of the yolk sac.

(b) Early manifestation and development of the fins.—About the first and the second week after hatching, the ventral, middorsal, and anal folds begin to disintegrate. Yellowish orange chromatophores appear among the original black chromatophores on the dorsal aspect of the head and along the lateral sides of the body.

Delicate fin rays become manifest on the caudal, mid-dorsal, and ventral folds about three to four weeks after the animal hatches (Plate 3, fig. 1). It is apparent that the second dorsal, anal, and caudal fins in *Gulaphallus mirabilis* develop synchronously. About five weeks after hatching, the second dorsal, anal, and caudal undergo rapid development, while the first dorsal fin is not yet in evidence (Plate 3, fig. 2).

(c) Early differentiation and development of the male copulatory organs.—In twelve of the twenty larvæ indications of the formative copulatory organs of the male are first seen at about the sixth or the seventh week after hatching. They appear as bilobed, posteriorly directed outgrowths originating from the ventral side of the throat region and extending to about the base of the pectoral fins (Plate 3, figs. 5 and 5a, cpa). The anal opening, a, is discernible between the bases of these two outgrowths. At about this time, the first dorsal fin also makes its appearance a few millimeters anterior to the second dorsal fin. The first dorsal fin at this stage possesses two spinous rays, which is characteristic of the genus.

During the eighth and the ninth week, the formative copulatory structures increase in size. By about the tenth week, one of the lobes outgrows the other and the two coalesce along the ental side (Plate 3, figs. 6 and 6a). About the twelfth and the thirteenth week (Plate 4, figs. 1 and 1a) the fused lobes develop into a more or less elongate subfusiform structure. At this stage this structure is intimately apposed along almost its entire length from the base subdistally to the throat of the fish. This stage marks the beginning of the development of the priapium.

(d) Early development of the priapium and manifestation of the priapial accessory appendages.—Fourteen weeks after the fish hatches, the priapium elongates. The anterior end of the priapium is in line with the centers of the eyes and the posterior end extended to about half beyond the pectoral fins (Plate 4, figs. 2 and 2a). The anus now begins to assume a lateral left or right position, on account of the twisting of the priapium. A cartilaginous protuberance, which is apparently the formative toxactinium, arises on the aproctal side lateral to the posterior part of the priapium (Plate 4, fig. 2a, tf). This formative structure cannot possibly be the formative penislike structure, because as seen in the subsequent stages, the latter is posteromesal in position.

About the fifteenth or the sixteenth week after the animal hatches, the formative penislike structure and the formative ctenactinium are already in evidence (Plate 4, figs. 3 and 3a). The formative penislike structure appears as a fleshy protuberance at the posterior end of the priapium. Because of the twisted condition of the priapium this structure seems to be inclined towards one side, adjoining the developing toxactinium. The formative ctenactinium appears as a slender cartilaginous thickening along the ventral side of the priapium. The priapium at this time increases considerably in length towards the anterior end to about the base of the lower jaw.

It appears that the priapial appendages are homologous lateral structures, one becoming the toxactinium and the other the ctenactinium, depending upon which side the priapium twists to. The toxactinium then is the one that ultimately retains a lateral position and the ctenactinium, the ventral. These two structures fuse together at their bases during the early stages of development, and probably develop from a common base.

(e) Later development of the priapium and its accessory appendages.—About seventeen weeks after the animal hatches, the distal part of the short ctenactinium (Plate 4, figs. 4 and 4a) is free. The toxactinium increases considerably in length until the tip is about in line with the centers of the eyes. The toxactinium and the ctenactinium at this stage of development are cartilaginous. At about the eighteenth week, four of the ten males in the culture have fully developed priapia and upon dissection are found to be sexually mature. At this stage also, the ctenactinium is completely free from the priapial muscle in its entire extent. The priapium when fully developed extends from the base of the lower jaw to the anterior limit of the throat. The posterior or basal end of the priapium is very much enlarged due to the complete development of the seminal vesicle (Plate 4, figs. 4 and 4a, sv).

The fully developed ctenactinium (Plate 4, figs. 5 and 5a) is broad and shorter than the toxactinium, and has an expanded tip, which is concave and emarginate distally. At this stage the toxactinium has increased further in length up to about the base of the lower jaw. The penislike structure, likewise, has apparently attained its maximum development; it is pointed anterolaterally, with the opening of the vas deferens at its somewhat forked tip. Its distal end is placed between the proximal portions of the toxactinium and the ctenactinium. It develops also an axial bone at this stage of development. In the remaining six males the priapia and accessory appendages become fully developed about nineteen to twenty weeks after hatching. full development of the priapium is an index of sexual maturity. Regan (1916) arrived at an identical conclusion in connection with this study on Myxopterygia and Neostethus bicornis, close relatives of Gulaphallus.

The fully developed toxactinium and ctenactinium (Plate 5, figs. 1 and 1a) is pliable, but bony instead of being cartilaginous. A part of the subdistal curve of the long ctenactinium rests in a groove formed by the lower jaw and the anterior portion of the priapium.

#### SUMMARY

- 1. Four members of the family Phallostethidæ are known in the Philippines, all from Luzon. These are *Mirophallus bikola*nus Herre, *Gulaphallus eximius* Herre, *Gulaphallus mirabilis* Herre, and *Gulaphallus amaricola* sp. nov.
- 2. A rather comprehensive treatise of the biology of *Gulaphallus mirabilis* Herre is presented in the present report.
- 3. Copulation in *G. mirabilis* is intromittent, the duration being one to two minutes.
- 4. In the aquarium the eggs of *Gulaphallus* are laid singly and attached to leaves and stems of *Ceratophyllum* by adhesive threadlike processes. The eggs receive no parental care after oviposition.
- 5. The fish spawns throughout the year, but spawning is at its height in December and January and rarest in May and June.
- 6. Three classes of ova are recognized as occurring simultaneously in the ovary of a spawning female; namely, the immature class (group I eggs), the intermediate class (group II eggs), and the maturing class (group III eggs).

- 7. The transformation of the immature group into the intermediate class of ova is gradual. The same is also true in the transformation of the intermediate class into the maturing class of ova.
- 8. The following salient points were observed in the embryology of G. mirabilis.
- (a) The blastodisc became differentiated about one hour after laying, and the first act of cleavage occurs about one hour later. Cleavage is bilateral and regular up to the 8-cell stage, becoming irregular from the 16-cell stage.
- (b) The periblast and periblastic nuclei become apparent about six hours after laying.
- (c) The germ ring becomes evident about twenty hours after laying. The subgerminal cavity and the embryonic shield are also apparent by this time.
- (d) The primitive streak appears about eight hours after oviposition.
- (e) The embryonic circulation and pigmentation becomes apparent in embryos about sixty-two hours after laying.
- (f) The primordial pectoral fins appear in embryos about one hundred two hours after laying, and by about fifty-eight hours later they differentiate into definitive pectoral fins.
- 9. The period of incubation of the eggs during the months covered by the experiment under laboratory conditions varies from eight to eleven days with an average of  $9.50 \pm 0.079$  days.
- 10. The following is a summary of the post-embryonic development of the fish.
- (a) The second dorsal, anal, and caudal fins appear synchronously about the third and fourth week after hatching.
- (b) The primordial copulatory organs of the male first appear at about the sixth or the seventh week after hatching. At about this time the first dorsal fin makes its appearance.
- (c) The early development of the priapium begins at about the twelfth and thirteenth week after hatching.
- (d) The anlage of the toxactinium becomes evident about fourteen weeks after hatching.
- (e) The anlagen of the penislike structure and of the ctenactinium make their appearance at about the fifteenth or the sixteenth week after hatching.
- (f) The priapial appendages appear to be externally homologous lateral structures, one becoming the toxactinium and the other the ctenactinium, depending on whether the priapium takes a dextral or a sinistral turn.

- (g) The toxactinium and the ctenactinium remain cartilaginous during the early stages of development. They become bony but pliable structures when fully developed at about the nineteenth or twentieth week.
- (h) The priapium reaches its maximum development at sexual maturity, about the eighteenth week.
- (i) The penislike structure attains its maximum development about eighteen weeks after hatching.

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## **ILLUSTRATIONS**

#### PLATE 1

- pv, pulvinulus; ct, ctenactinium; p, penislike structure; co, comblike projections; a, anus; o, opening of oviduct; pl, papilla.
- Fig. 1. Gulaphallus amaricola sp. nov., male; 1a, ventral aspect of head region of male. (Drawn by E. Borbe.)
  - 2. Gulaphallus amaricola sp. nov., female; 2a, ventral aspect of head region of female. (Drawn by E. Borbe.)

#### PLATE 2. EGGS OF GULAPHALLUS MIRABILIS HERRE

- Fig. 1. Immature egg,  $\times$  80.
  - 2. Intermediate egg,  $\times$  100.
  - 3. Maturing egg,  $\times$  52.
  - Newly laid egg (× 40) attached to a twig of Ceratophyllum demersum Linn. by adhesive threads, at.
  - 5. One hour after oviposition; bd, blastodisc.
  - 6. Two hours after oviposition.
  - 7. Three hours after oviposition.
  - 8. Four hours after oviposition.
  - 9. Five hours after oviposition.
  - 10. Six hours after oviposition; pb, periblast.
  - 11. Nine hours after oviposition.
  - 12. Twenty hours after oviposition; gr, germ ring; sg, subgerminal cavity; es, embryonic shield; pp, embryonic pole.
  - 13. Twenty-eight hours after oviposition; ps, primitive streaks.
  - 14. Thirty-six hours after oviposition; sm, somite.
  - 15. Forty-eight hours after oviposition; 14 to 16 somites.
  - 16. Sixty-two hours after oviposition; h, heart.
  - 17. Eighty-eight hours after oviposition.
  - 18. One hundred two hours after oviposition; pa, pectoral anlagen.
  - 19. One hundred twenty-six hours after oviposition.
  - 20. One hundred sixty hours after oviposition.
  - 21. Two hundred hours after oviposition.
  - 22. Newly hatched larva,  $\times$  40; ys, yolk sac.

#### PLATE 3. GULAPHALLUS MIRABILIS HERRE

- Fig. 1. Three weeks after hatching, × 25. (Drawn by P. R. Manacop.)
  - 2. Five weeks after hatching, × 25. (Drawn by P. R. Manacop.)
  - 3. Gulaphallus mirabilis Herre, female, internal organs in situ, × 10. (Drawn by P. R. Manacop.)
  - Gulaphallus mirabilis Herre, male, internal organs in situ, × 8.
     (Drawn by P. R. Manacop.)
    - t, Testis; ov, ovary; sv, seminal vesicle; p, penislike structure; a, anus; i, coiled intestine; s, stomach; ab, air bladder; u, ureter; o, oviduct opening.

- Fig. 5. Six to seven weeks after hatching, × 10; a, anus; cpa, formative copulatory organ; 5a, ventral aspect of same. (Drawn by P. Medel.)
  - 6. Ten weeks after hatching,  $\times$  10;  $6\alpha$ , ventral aspect of same. (Drawn by P. Medel.)

## PLATE 4. (DRAWN BY P. MEDEL)

- Fig. 1. Twelve to thirteen weeks after hatching,  $\times$  10; a, anus; 1a, ventral aspect of same.
  - 2. Fourteen weeks after hatching,  $\times$  10; tf, formative toxactinium; a, anus; 2a, ventral aspect of same.
  - 3. Fifteen to sixteen weeks after hatching,  $\times$  10; 3a, ventral aspect of same; ps, formative penislike structure; t, toxactinium; c, formative ctenactinium.
  - 4. Seventeen weeks after hatching,  $\times$  10; 4a, ventral aspect of same; sv, seminal vesicle.
  - 5. Eighteen weeks after hatching; 5a, ventral aspect of same.

## PLATE 5. (DRAWN BY P. MEDEL)

- Fig. 1. Nineteen to twenty weeks after hatching, × 10; 1a, ventral aspect of same to show fully developed priapial appendages; c, ctenactinium; t, toxactinium; ps, penislike structure.
  - 2. Gulaphallus mirabilis Herre, in copulation,  $\times$  6.

#### TEXT FIGURES

- Fig. 1. Diameter frequencies of ova during the spawning season, Molawin Creek, November, 1930, to October, 1931. (Based on Table 1.)
  - Yearly proportions of food items consumed by the immature Gulaphallus.
  - Yearly proportions of food items consumed by the mature Gulaphallus.



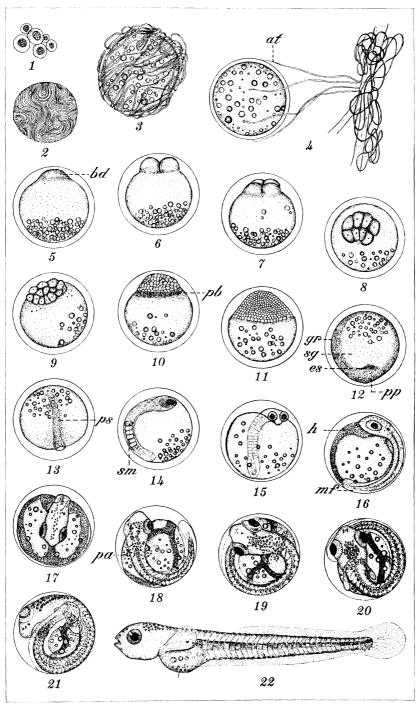


PLATE 2.



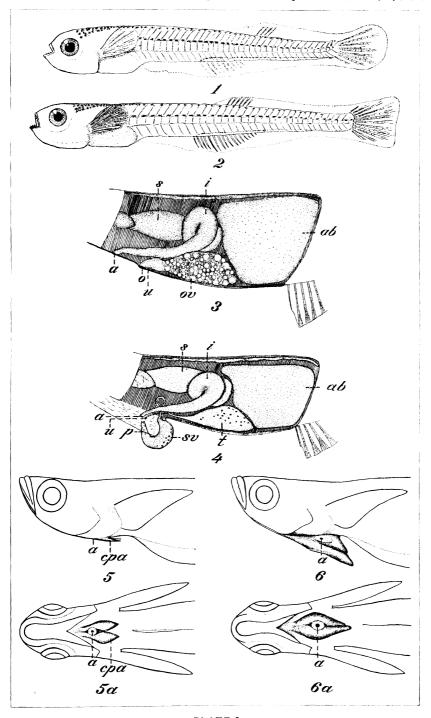


PLATE 3.

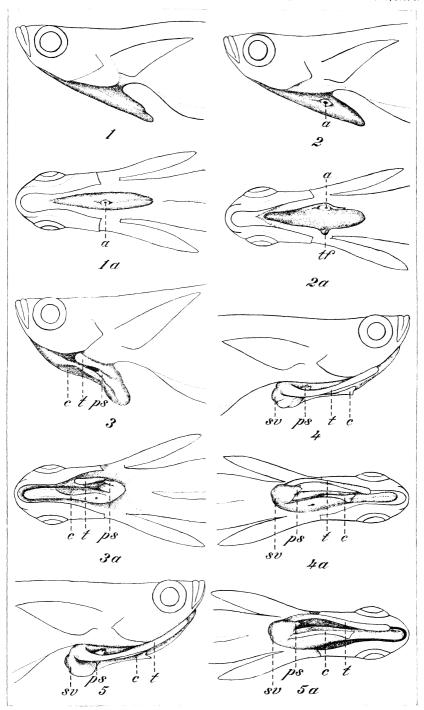


PLATE 4.



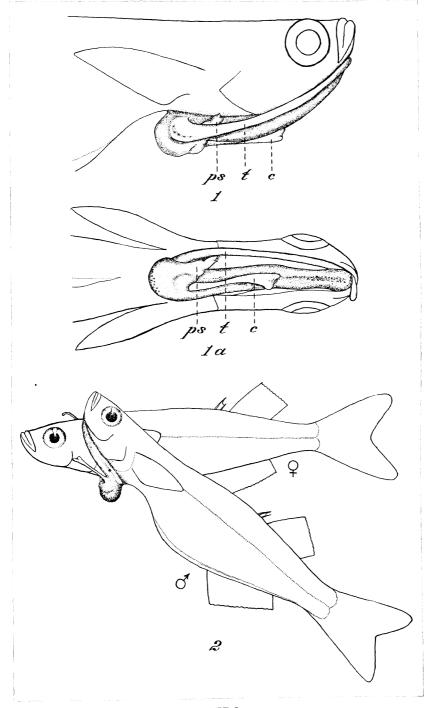


PLATE 5.

## PHILIPPINE SILLAGINIDÆ

By CLARO MARTIN and HERACLIO R. MONTALBAN

Of the Fish and Game Administration, Bureau of Science, Manila

#### ONE PLATE

In the present paper is given a review of Philippine fishes belonging to the family Sillaginidæ, based on material in the collection of the Fish and Game Administration. Three species are herein described, one of which is believed to be new to science.

## SILLAGINIDÆ

Body elongate, little compressed, tapering both ways from the spinous dorsal; head conical, with its muciferous system fully developed as in the Sciænidæ; eyes lateral, nearly median; preorbital very large, concealing the ends of maxillaries; mouth small, terminal, and slightly oblique, the upper jaw slightly the longer: villiform teeth in the jaws with the outer row rather conical, enlarged, and curved inward; teeth on vomer, none on palatines; preopercle serrated or crenulated; opercle armed behind with a short, flat spine; scales small, ctenoid, and cycloid; lateral line simple, slightly curved in front, and continued to base of caudal or a little beyond; two separate dorsal fins, the first short and consisting wholly of spines, the second very long. with one spine and over 17 rays; anal similar to second dorsal, with 2 spines; caudal emarginate; pectorals normal; ventral I, 5; branchiostegals 6; pseudobranchiæ present; air bladder simple: pyloric cæca few.

Fishes of this family are found from the Red Sea through the East Indies to Samoa, ranging northward to China, Korea, and Japan, and southward through the Philippines to the southeast of Australia. They are closely related to the Sciænidæ and are known to ascend rivers and estuaries. Their flesh is esteemed as light and wholesome food.

#### Genus SILLAGO Cuvier

Sillago Cuvier, Regne Animal, 1st ed. 2 (1817) 258.

This genus includes most of the species of the family, including all those with villiform teeth, in which the soft dorsal and anal are similar to each other, scales small, and the ventral spine normal.

## Key to the Philippine species of Sillago.

- a<sup>2</sup>. Dorsal fins XI-I, 17 to 19; anal II, 17 or 18; silvery longitudinal band on each side of body well pronounced; scales on cheek in three or four rows, cycloid or ctenoid.
  - b. With irregular blackish blotches on sides; longitudinal band narrow; scales on cheek ctenoid, in four rows.

S. maculata Quoy and Gaimard.

#### SILLAGO SIHAMA (Forskål). Plate 1, fig. 1.

Atherina sihama Forskål, Descr. Anim. (1775) 70.

Platycephalus sihamus Bloch and Schneider, Syst. Ichth. (1801) 60. Sciaena malabarica Bloch and Schneider, Syst. Ichth. (1801) 81; Cantor, Cat. Malay. Fish. (1850) 1003.

Sillago acuta CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 296; BLEEKER, Percoidea, Verh. Batav. Gen. 22 (1849) 61; Kner, Reise, Novara (1865–1887) 128.

Sillago erythræa Cuvier and Valenciennes, Hist. Nat. Poiss. 3 (1829) 301.

Sillago sihama RÜPPELL, Reise, Nord. Afrika, Atlas (1826-31) 9, pl. 3, fig. 1; GÜNTHER, Cat. Fish. Brit. Mus. 2 (1860) 243; KLUNZINGER, Abh. Zool. Bot. Ges. Wien 20 (1870) 818; Sitzber. Akad. Wien (1880) 369; Fische Rothen Meeres (1884) 123; BLEEKER, Verh. Akad. Ams. 14 [(1873) 1874] 67; Atlas, Ichth. 9 (1877) pl. 389, fig. 4; DAY, Fish. India (1878-1888) 265; STEINDACHNER and DÖDERLEIN, Denkschr. Akad. Wien 49 (1884) 192; JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1902) 486; GILCHRIST and THOMPSON, Ann. South Afric. Mus. 6 pt. 2 (1908) 192; FOWLER and BEAN, Proc. U. S. Nat. Mus. 62 (1922) 68; CHAUDHURI, Mem. Indian Mus. 5 (1923) 721; BARNARD, Ann. South Afric. Mus. 21 (1925-27) 507; FOWLER, Mem. Bishop Mus. 10 (1928) 235; WEBER and DE BEAUFORT, Fishes Indo-Austr. Arch. 6 (1931) 172, fig. 33; FOWLER, Bull. No. 100, U. S. Nat. Mus. 12 (1933) 417.

Dorsal XI-I, 20 to 22; anal II, 21 to 23; scales on lateral line to base of caudal 68 to 70; between lateral line and origin of dorsal 5; between lateral line and origin of anal 11.

Body slender and slightly compressed, its depth 5.2 to 6.1 in length; dorsal profile not much elevated, with the anterior portion rising evenly and gently from snout to dorsal fin; ventral outline nearly straight; head elongate, 3.2 to 3.9 in length of body; caudal peduncle narrow and short, its least depth 3.2 to 4.2 in head; interorbital space slightly convex, 4.9 to 6 in head;

eye large and ellipsoidal, located midway between tip of snout and posterior edge of preopercle, its maximum diameter 3.2 to 4.3 in the head; snout long and pointed, nearly twice as long as the maxillary, which is 4.1 to 5 in head; greatest width of preorbital very slightly exceeding the diameter of eye, 2.9 to 3.5 in head; mouth small, somewhat oblique, with the upper jaw a trifle the longer; teeth villiform in both jaws, those in the outer row slightly enlarged and directed inward; a broad patch of vomerine teeth present.

Body, nape, and opercle covered with finely ctenoid scales; those on preopercle and throat cycloid, on frontal cycloid and ctenoid; cheeks with two rows of cycloid scales, sometimes with small ones between; proximal two-thirds of supraorbital with four to five rows of very small ctenoid scales and the rest of head naked; all fins scaly; dorsals separate, the first one higher than the second and inserted on a line passing a little behind base of ventrals; origin of second or rayed dorsal opposite that of anal, both fins about equal in length; pectoral 1.7 to 1.9 in head and almost as long as ventral, both fins pointed; caudal emarginate.

Ground color of fresh specimens greenish olive, washed with grayish above lateral line from nape to caudal peduncle and becoming light silvery white below; an indistinct silvery yellowish longitudinal band below lateral line on posterior two-thirds of body; top of head to tip of snout dusky; preorbital grayish above and yellowish below; lower jaw, posterior half of premaxillary, cheek, and upper half of opercle yellow; spinous dorsal dotted with blackish and tipped with black to the sixth or eighth spine; soft dorsal tipped with blackish, the minute dots on membrane forming a blackish vertical band in front of each ray; pectoral yellowish gray; ventral and anal yellowish; caudal yellowish, with a broad margin of blackish above, below, and behind.

Alcoholic specimens slightly yellowish to brownish, generally lighter to dull silvery white at belly and grayish above lateral line from occiput to caudal peduncle; in many specimens a faint trace of dull silvery white longitudinal band present on posterior half of side to middle portion of caudal peduncle, in some it is absent; spinous and soft dorsals finely dotted with grayish and with blackish narrow edge; caudal yellowish, with outward portions of rays grayish; other fins yellowish.

Fifty specimens were examined, varying from 58 to 290 millimeters in length. They were collected at the following localities:

LUZON, Cagayan Province, Abulog: Ilocos Norte Province, Bangui: Ilocos Sur Province, Vigan: Zambales Province, Iba, Subic: Pampanga Province, Macabebe: Bulacan Province, Paombong: Manila: Rizal Province, Pasay: Batangas Province, Nasugbu, Balayan Bay: Camarines Sur Province, Sibubu, San Miguel Bay: Albay Province, Legaspi. MINDORO, Mindoro Province, Pinamalayan. Samar, Samar Province, San Pedro Bay. Leyte, Leyte Province, Dulag, Carigara. Panay, Iloilo Province, Barotac Nuevo, La Paz, Molo, Zarraga. Negros, Negros Oriental Province, Tanjay. Palawan, Palawan Province, Guinlo, Puerto Princesa, Panacan. MINDANAO, Agusan Province, Agusan: Misamis Province, Cagayan: Davao Province, Davao.

This species is common in the Philippines and occurs from the Red Sea through seas of India to the Malay Archipelago, ranging northward to China, Japan, and Korea, and eastward to Samoa. It ascends tidal waters and reaches a length of more than one foot. It has been recorded by Günther from the Philippine Islands, by Jordan and Seale from Cavite and Negros Island, and by Jordan and Richardson from Aparri.

## SILLAGO MACULATA Quoy and Gaimard. Plate 1, fig. 2.

Sillago maculata Quoy and GAIMARD, Voy. Uranie et Physicienne (1824) 261, pl. 53, fig. 2; Cuvier and Valenciennes, Hist. Nat. Poiss. 3 (1829) 303; Bleeker, Verh. Bat. Gen. 22 (1849) 62; Verh. Akad. Ams. 14 (1874) 71; Nat. Tijdschr. Ned. Indië 13 (1858-59) 161; Verh. Akad. Ams. 14 [(1873) 1874] 71; Atlas Ichth. 9 (1877) 389, fig. 5; Günther, Cat. Fish. Brit. Mus. 2 (1860) 245; Kner, Novara-Exp. Fische (1865-67) 127; Day, Fishes of India (1878) 265; Macleay, Descr. Cat. Austr. Fish. 1 (1881) 201; McCulloch, Austr. Zool. 1 (1919) 51; Barnard, Ann. S. African Mus. 21 (1925-28) 508; Weber and De Beaufort, Fishes Indo-Austr. Arch. 6 (1931) 174; Fowler, U. S. Nat. Mus. Bull. No. 100 12 (1933) 423.

Sillago burrus RICHARDSON, Icon. Piscium (1843) 5.

Sillago gracilis Alleyne and Macleay, Proc. Linn. Soc. N. S. W. 1 (1877) 279, pl. 6, fig. 2.

Dorsal XI-I, 19; anal II, 17 or 18; scales on lateral line to base of caudal 69; between lateral line and origin of dorsal 6; between lateral line and origin of anal 13.

Body elongate and slightly compressed, with dorsal outline fairly well arched and ventral contour nearly straight; depth 4.5 to 5.2 in length; greatest depth of head nearly twice in its length which is 3.2 to 3.4 in that of body; caudal peduncle narrow and compressed, its least depth 3.4 to 3.9 in head; interorbital space slightly convex, 5 to 5.6 in head; eye large and ellipsoidal, located closer to posterior edge of opercle than to tip of snout, its maximum diameter 3.3 to 3.6 in head; snout rather pointed, 2.4 to 2.5 in head; maxillary a little shorter than eye, being 4 to 4.4 in head and reaching to nearly halfway below front edge of eye; greatest width of preorbital 2.9 to 3.2 in head; mouth small and slightly oblique, with the upper jaw a trifle the longer; teeth villiform in both jaws, the outer row a little enlarged and curved inward; a band of teeth on vomer; vertical limb of preopercle finely serrated; opercle with a small spine behind.

Scales on body, nape, and opercle ctenoid, those on cheek ctenoid, in four rows; scales on preopercle and throat cycloid, on frontal both cycloid and ctenoid; a patch of fine scales on supraorbital; scales also present on all fins; first dorsal higher than the second, its spines weak and decreasing in height from the second which is 1.9 to 2.6 in head, pectoral 1.6 to 2 in head; ventral a little shorter than pectoral; caudal forked.

Ground color in alcohol yellowish to brownish, slightly grayish along back, becoming dull white on abdomen; some irregular blackish blotches on sides; a dull silvery longitudinal band running from above base of pectoral to caudal peduncle; upper half of spinous dorsal blackish; outer edges of soft dorsal blackish, the rest of fin with two longitudinal bands of like color; caudal washed with grayish behind; other fins colorless.

The above description is taken from five specimens, 90.5 to 147.7 millimeters in length, collected from the following places:

LUZON, Manila. LEYTE, Leyte Province, Tacloban. PANAY, Iloilo Province, Estancia. PALAWAN, Palawan Province, Panacan.

This well-marked species ranges from the Andamans, through the Malay Archipelago, to the southeast of Australia. It is said to attain 8 or 9 inches in length.

This fish has been reported by Kner from Manila.

SILLAGO ARGENTIFASCIATA sp. nov. Plate 1, fig. 3.

Dorsal XI-I, 17 or 18; anal II, 17; scales on lateral line to base of caudal 66; between lateral line and origin of dorsal 5; between lateral line and origin of anal 9.

Body slender, a little compressed, its depth 4.9 to 5.3 in length; dorsal and ventral profiles evenly and almost equally arched, the deepest portion at origin of second dorsal and anal; head elongate, rather sharply pointed, 3.3 to 3.4 in length of body; caudal peduncle compressed, its least depth 11.6 to 12.1 in length of body, 3.4 to 3.6 in head; eye large and ellipsoidal, located slightly nearer posterior edge of opercle than tip of snout, its maximum diameter 3.4 to 3.5 in head; interorbital space flat, almost 2 in snout and 5.5 to 5.6 in head; snout pointed, 2.4 to 2.6 in head, its upper outline very slightly arched; maxillary 4.3 to 4.9 in head and 1.8 to 1.9 in snout, ending behind halfway between tip of snout and vertical through anterior edge of eye; greatest width of preorbital 2.9 to 3.4 in head; mouth small and slightly oblique; lower jaw a little included; vertical limb of preopercle serrated; teeth villiform in both jaws, those in outer row enlarged and bent forward; a band of teeth on vomer.

Body, nape, and opercle covered with finely ctenoid scales; cheek with three rows of scales, those on upper row cycloid and on lower two rows ctenoid; preopercle and throat with cycloid scales; frontal scales both cycloid and ctenoid; caudal scaly, rest of fins naked; a patch of small scales present on supra-orbital; dorsal spines decreasing in height to the last, the first one 2.2 to 2.4 in head; pectoral longer than ventral, 1.7 to 1.8 in head; caudal deeply forked.

Ground color in alcohol dull silvery white; a well-pronounced, brilliant, silvery, longitudinal band, widest between the anterior portions of anal and second dorsal, runs on side from above base of pectoral to base of caudal; anteriorly this band is below the lateral line and posteriorly its upper edge touches it; breast and opercle brilliant silvery; upper portion of each dorsal spine and ray sparsely dotted with blackish; all other fins hyaline.

This species is distinct in having three rows of scales on the cheek and a wide, brilliant, silvery, longitudinal band on each side of the body.

Here described from the type, No. 15680. Cotypes, Nos. 31146 and 31147, all deposited in the collection of the Fish and Game Administration; all obtained November 29, 1927, at Lumbucan Island, Palawan. The three specimens range in size from 81.8 to 116.3 millimeters.

Argentifasciata, silver-banded.

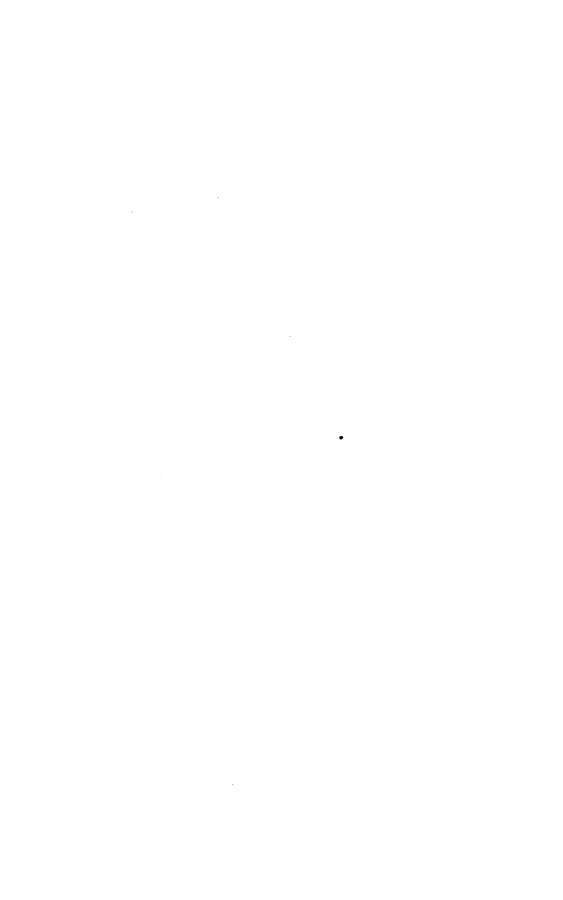


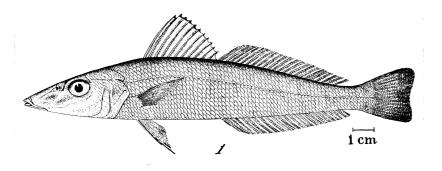
## **ILLUSTRATION**

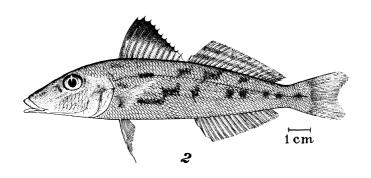
## PLATE 1

- Fig. 1. Sillago sihama (Forskål); natural size. Drawn by Pablo Bravo.
  - 2. Sillago maculata (Quoy and Gaimard); natural size. Drawn by Antonio Canlas.
  - 3. Sillago argentifasciata sp. nov.; natural size. Drawn by Pablo Bravo.

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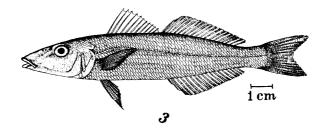


PLATE 1.



## A REVIEW OF PHILIPPINE ISOSPONDYLOUS FISHES

By HILARIO A. ROXAS

Of the Fish and Game Administration, Bureau of Science, Manila

#### THREE PLATES

Although the isospondylous fishes comprise some of the most important food fishes of the Philippines and are encountered in the market the year around, nothing extensive on their taxonomy has been written. In the collection of the Fish and Game Administration are numerous examples of fishes belonging to this order, which have been gathered from various parts of the Archipelago by various persons since 1907. An attempt is made here to present a systematic record of this material, so that the confusion arising from wrong identification and from nonuniformity of taxonomic treatment may be partially if not completely eliminated. Günther (1887), Smith and Seale (1906), Jordan and Seale (1907), Evermann and Seale (1907), Seale and Bean (1907), Jordan and Richardson (1908), Fowler (1918, 1931), and Herre (1927, 1934) mentioned some of the species of this order. This is the first time, however, that detailed descriptions and complete synonyms of all the Philippine representatives of the group are given in one paper.

This is the second paper dealing with the systematics of Philippine fishes that are of economic or commercial importance. As is mentioned in a previous paper (Roxas, 1934), these studies on taxonomy have to be made before the breeding habits, life histories, and feeding habits of these animals can be adequately studied.

The isospondylous fishes are bony fishes whose fins do not possess true spines, being provided mostly with soft fin rays. The ventral fins, if present, are always abdominal in position. The tail is homocercal, but the hæmal supports are fused or not much expanded. The opercle is well developed, and its bones are complete. The pectoral arches are suspended from the cranium. In the living (nonextinct) forms the air bladder is connected with the œsophagus in the adult. The spiral value of the intestine is either incomplete or wanting.

Previously reported examples of isospondylous fishes in the Philippines belong to twelve families, thirty genera, and fifty-one species, as shown in the following check list:

## ELOPIDÆ

#### ELOPS HAWAIENSIS Regan.

Elops saurus Evermann and Seale (1906) Bulan; Jordan and Richardson (1907) Manila.

Elops hawaiiensis Fowler (1918) Philippines; Herre (1934) Manila, Capiz, and Dumaguete.

Elops hawaiensis Fowler (1927) Orani.

#### MEGALOPS CYPRINOIDES (Broussonet).

Megalops cyprinoides Jordan and Seale (1905) Negros; Evermann and Seale (1906) Bulan; Weber and de Beaufort (1913) Philippines; Fowler (1918) Philippines; Fowler (1927) Vigan, Orion, Philippines; Herre (1934) Bauang Sur, Bulacan, Manila.

## ALBULIDÆ

#### ALBULA VULPES (Linnæus).

Albula vulpes Herre (1934) Jolo.

# **CHANIDÆ**

#### CHANOS CHANOS (Forskål).

Chanos chanos Jordan and Seale (1906) Cavite; Jordan and Richardson (1907) Manila; Evermann and Seale (1907) Manila; Seale and Bean (1907) Zamboanga; Fowler (1918) Philippines; Fowler (1927) San Fernando, Vigan, Orani, Philippines; Herre (1934) Bulacan, Malabon, Cavite, Capiz, La Paz (Iloilo), Dumaguete.

## CHIROCENTRIDÆ

## CHIROCENTRUS DORAB (Forskål).

Chirocentrus dorab Jordan and Seale (1906) Cavite; Evermann and Seale (1906) San Fabian, Bacon; Jordan and Richardson (1907) Manila; Weber and de Beaufort (1913) Philippines; Fowler (1918) Philippines; Fowler (1922) Cebu; Fowler (1927) Vigan; Herre (1934) Unisan, Capiz, Cebu, Dumaguete, Jolo.

#### DUSSUMIERIIDÆ

## SPRATELLOIDES GRACILIS (Schlegel).

Stolephorus gracilis Evermann and Seale (1906) Bacon. Spratelloides gracilis Weber and de Beaufort (1913) Philippines.

## SPRATELLOIDES DELICATULUS (Bennett).

Stolephorus delicatulus Evermann and Seale (1906) Bacon and Bulan; Fowler (1927) Bacon.

Spratelloides delicatulus Weber and de Beaufort (1913) Philippines; Herre (1934) Calapan, Culion, Dumaguete.

## DUSSUMIERIA ACUTA Cuvier and Valenciennes.

Dussumieria acuta Kner (1865) Manila; Weber and de Beaufort (1913) Philippines; Fowler and Bean (1922) Cebu; Deraniyagala (1929) Philippines.

Dussumieria elopsoides Jordan and Seale (1906) Cavite; Jordan and Richardson (1907) Iloilo.

#### DUSSUMIERIA HASSELTII Bleeker.

Dussumieria hasseltii Jordan and Richardson (1907) Manila; Weber and de Beaufort (1913) Philippines; Fowler (1918) Philippines; Fowler (1927) San Fernando, Orani, Orion, Philippines; Herre (1934) Gulf of Lingayen, La Union Province, Unisan, La Paz, (Iloilo), Cebu.

#### ETRUMEUS ALBULINA Fowler.

Etrumeus albulina Fowler (1934) Iloilo.

## DOROSOMIDÆ

#### NEMATALOSA NASUS (Bloch).

Konosirus thrissa Evermann and Seale (1906) Philippines; Herre (1934) Sitanki.

Konosirus nasus Seale and Bean (1907) Zamboanga.

Dorosoma nasus Weber and de Beaufort (1913) Philippines.

Nematalosa nasus Herre (1934) Culion.

## ANODONTOSTOMA CHACUNDA (Hamilton-Buchanan).

Anodontostoma chacunda Evermann and Seale (1906) Bacon; Jordan and Seale (1906) Cavite; Jordan and Richardson (1907) Manila and Iloilo; Fowler (1918) Philippines; Fowler (1927) San Fernando, Santa Maria, Orani, Orion, Philippines; Fowler (1931) Philippines; Herre (1934) Bauang Sur, Manila.

Dorosoma chacunda Weber and de Beaufort (1913) Philippines.

## ENGRAULIDÆ

### THRISSINA BÆLAMA (Ferskål).

Anchovia baelama Jordan and Richardson (1907) Cagayancillo and Iloilo; Seale and Bean (1907) Zamboanga.

Engraulis baelama Weber and de Beaufort (1913) Philippines; Fowler (1927) Sta. Maria.

Thrissina baelama Herre (1934) Capiz, Cebu, Cotabato.

## SCUTENGRAULIS HAMILTONII (Gray).

Engraulis hamiltonii (1907) Manila, Iloilo; Fowler (1927) Philippines.

Engraulis grayi Weber and de Beaufort (1913) Philippines.

## THRISSOCLES SETIROSTRIS (Broussonet).

Anchovia setirostris Jordan and Richardson (1907) Aparri.

Engraulis setirostris Weber and de Beaufort (1913) Philippines; Fowler (1927) Philippines.

Thrissocles setirostris Fowler (1931) Philippines; Herre (1934) Bauang Sur, Capiz.

## ENGRAULIS DUSSUMIERI Cuvier and Valenciennes.

Engraulis dussumieri Herre (1934) Dumaguete.

### ENGRAULIS VALENCIENNESI (Bleeker).

Engraulis valenciennesi Fowler (1927) Orani.

### STOLEPHORUS HETEROLOBUS Rüppell.

Stolephorus heterolobus Herre (1934) Dumaguete.

#### STOLEPHORUS COMMERSONII Lacépède.

Anchovia commersoniana Jordan and Seale (1906) Cavite.

Anchovia commersonii Fowler (1918) Philippines; Fowler (1927) San Fernando, Bangued, Sta. Maria, Vigan, Philippines.

Scutengraulis commersonii Fowler (1931) Philippines.

Stolephorus commersoni Herre (1934) Bauang Sur, Dumaguete.

### STOLEPHORUS INDICUS (van Hasselt).

Anchovia indica Jordan and Seale (1906) Cavite; Evermann and Seale (1906) Bulan.

Engraulis indicus Fowler (1927) Orion, Philippines.

Stolephorus indicus Weber and de Beaufort (1913) Philippines; Herre (1934) Cebu, Dumaguete, Atimonan.

Scutengraulis indica Fowler (1931) Philippines.

#### STOLEPHORUS TRI (Bleeker).

Stolephorus tri Weber and de Beaufort (1913) Philippines; Herre (1934) Bauang Sur, Manila, Cotabato.

Engraulis tri Fowler (1927) Sta. Maria, Orion, Orani, Philippines. Scutengraulis tri Fowler (1931) Philippines.

## CLUPEIDÆ

## CLUPEOIDES LILE (Cuvier and Valenciennes).

Clupeoides lile Herre (1934) Unisan, Dumaguete.

#### SARDINELLA LEIOGASTER Cuvier and Valenciennes.

Sardinella leiogaster Herre (1934) Jolo.

### SARDINELLA CLUPEOIDES (Bleeker).

Sardinella clupeoides Evermann and Seale (1906) Bulan; Herre (1934) Culion.

Clupea (Amblygaster) clupeoides Weber and de Beaufort (1913) Philippines.

## SARDINELLA SIRM (Rüppell).

Clupea (Amblygaster) sirm Weber and de Beaufort (1913) Philippines.

Sardinella sirm Fowler (1931) Philippines; Herre (1934) Dumaguete.

#### SARDINELLA BRACHYSOMA (Bleeker).

Sardinella brachysoma Fowler (1927) Sta. Maria, Orani, Orion; Fowler (1931) Philippines.

#### SARDINELLA MELANURA (Cuvier and Valenciennes).

Harengula vanicoris Jordan and Seale (1906) Philippines.

Clupea melanura Seale and Bean (1907) Zamboanga.

Clupea (Harengula) melanura Weber and de Beaufort (1913) Philippines.

Sardinella melanura Fowler (1927) Vigan, Sta. Maria; Herre (1934) Cape Bolinao, Pangasinan.

# SARDINELLA PERFORATA (Cantor).

Sardinella rerforata Evermann and Seale (1906) Bacon; Fowler (1931) Philippines; Herre (1934) Manila.

Clupea (Harengula) perforata Weber and de Beaufort (1913) Philippines.

## SARDINELLA FIMBRIATA (Cuvier and Valenciennes).

Harengula gibbosa Jordan and Seale (1906) Negros; Jordan and Richardson (1907) Manila.

Harengula sundaica Jordan and Richardson (1907) Manila, Iloilo, Aparri.

Clupea (Harengula) fimbriata Weber and de Beaufort (1913) Philippines.

Clupea (Harengula) fimbriata Deraniyagala (1929) Philippines.

Sardinella fimbriata Fowler (1918) Philippines; Fowler (1927) Bacon; Fowler (1931) Philippines; Herre (1934) Bauang Sur, Manila, Nasugbu, Alabat Islands.

## SARDINELLA LONGICEPS Cuvier and Valenciennes.

Sardinella longiceps Fowler (1927) Orion; Herre (1931) Estancia, Culion, Manila market.

## SARDINELLA SCHRAMMI (Bleeker).

Harengula schrammi Fowler (1927) Sta. Maria, Vigan, San Fernando; Herre (1934) Dumaguete.

## SARDINELLA JUSSIEU (Lacépède).

Sardinella jussieu Fowler (1927) Vigan; Orani, Orion; Philippines.

### HARENGULA DISPILONOTUS Bleeker.

Harengula dispilonotus Herre (1931) Cebu; Fowler (1934) Philippines.

## HARENGULA TAWILIS Herre.

Harengula tawilis Herre (1927) Lake Taal; Herre (1934) Lake Bombon.

#### HARENGULA MOLUCCENSIS Bleeker.

Harengula moluccensis Jordan and Seale (1906) Cavite; Evermann and Seale (1906) Bacon, Bulan; Jordan and Richardson (1907) Manila; Seale and Bean (1907) Zamboanga; Herre (1934) Jolo, Dumaguete.

Clupea (Harengula) moluccensis Weber and de Beaufort (1913) Philippines.

Harengula punctata Herre (1934) Unisan, Culion, Dumaguete.

#### ILISHA HOEVENII Bleeker.

Ilisha hoevenii Evermann and Seale (1906) San Fabian; Jordan and Seale (1906) Cavite; Jordan and Richardson (1907) Manila; Fowler (1918) Philippines; Fowler (1927) Orion, Philippines; Herre (1934) Manila.

Pellona hoevenii Weber and de Beaufort (1913) Philippines.

### ILISHA DITCHOA Cuvier and Valenciennes.

Pellona ditchoa Herre (1934) La Paz, Iloilo.

## ALEPOCEPHALIDÆ

#### ALEPOCEPHALUS ANDERSONI Fowler.

Alepocephalus andersoni Fowler (1934) between Siquijor and Bohol in 392 fathoms.

## BATHYTROCTES HATAII Fowler.

Bathytroctes hataii Fowler (1934) east coast of Luzon; in 300 fathoms.

#### NARCETES LLOYDI Fowler.

Bathytroctes lloydi Fowler (1934) east coast of Luzon, in 565 fathoms.

#### NARCETES GARMANI Fowler.

Narcetes garmani Fowler (1934) China Sea, vicinity of southern Luzon, in 248 fathoms.

## MICROSTOMIDÆ

## MICROSTOMA SCHMITTI Fowler.

Microstoma schmitti Fowler (1934) east coast of Luzon, in 383 fathoms.

## STERNOPTYCHIDÆ

#### POLYIPNUS SPINOSUS Günther.

Polyipnus spinosus Günther (1887) Sta. 200, between the Philippine Islands and Borneo.

#### STERNOPTYX DIAPHANA Hermann.

Sternoptyx diaphana Günther (1887) Sta. 214, Philippine Islands.

## STOMIATIDÆ

#### STOMIAS AFFINIS Günther.

Stomias affinis Günther (1887) Sta. 23, South of Sombrero Island, Philippines.

### MALACOSTEUS INDICUS Günther.

Malacosteus indicus Günther (1887) Sta. 214, near Philippine Islands.

### ELAPTEROSTOMIAS PHILIPPINUS Fowler.

Elapterostomias philippinus Fowler (1934) China Sea, vicinity of southern Luzon, in 524 fathoms.

## PSEUDOEUSTOMIAS MYERSI Fowler.

Pseudoeustomias myersi Fowler (1934) Sulu Sea, vicinity of southern Panay, in 411 fathoms.

#### MELANOSTOMIAS STEWARTI Fowler.

Melanostomias stewarti Fowler (1934) Dupon Bay, Leyte.

# MELANOSTOMIAS GLOBULIFER Fowler.

Melanostomias globulifer Fowler (1934) west coast of Luzon, in 297 fathoms.

## MELANOSTOMIAS VIERECKI Fowler.

Melanostomias vierecki Fowler (1934) east of Masbate, in 604 fathoms.

The following species previously accredited to the Philippine Islands are not represented in the collection of the Fish and Game Administration. Bureau of Science.

Spratelloides gracilis (Schlegel).

Engraulis dussumieri Cuvier and Valenciennes.

Engraulis valenciennesi Fowler.

Etrumeus albulina Fowler.

Stolephorus heterolobus Rüppell.

Sardinella leiogaster Cuvier and Valenciennes.

Sardinella clupeoides (Bleeker).

Sardinella brachysoma (Bleeker).

Sardinella schrammi (Bleeker).

Ilisha ditchoa Cuvier and Valenciennes.

Alepocephalus andersoni Fowler.

Bathytroctes hataii Fowler.

Narcetes lloydi Fowler.

Narcetes garmani Fowler.

Microstoma schmitti Fowler.

Polyipnus spinosus Günther.

Stomias affinis Günther.

Malacosteus indicus Günther.

Elapterostomias philippinus Fowler.

Pseudoeustomias myersi Fowler.

Melanostomias stewarti Fowler.

Melanostomias globulifer Fowler.

Scutengraulis mystax (Bloch) and Valenciennellus tripunctulatus (Esmark) are recorded in the Philippines for the first time. A new species of Sardinella is described in this paper.

Key to the Philippine families of the order.

a <sup>1</sup> . Lateral line present.	
b 1. Gular plate present between branches of lower jaw	ELOPIDÆ.
b <sup>2</sup> . No gular plate.	
c¹. Teeth present	ALBULIDÆ.
c 2. Teeth absent	CHANIDÆ.

- a2. No lateral line.
  - b 1. No adipose fin; no photophores; parietals present.
    - $c^{1}$ . Abdominal edge without scutes.
      - d'. Belly carinate, sharp; teeth long; scales very small.

CHIROCENTRIDÆ.

- d. Belly rounded, teeth short; scales moderate...... Dussumieridæ. c. Abdominal edge with scutes.

  - d. Mouth large; maxillary with two supplemental bones; teeth usually present.
    - e1. Snout prominent; mouth usually oblique, maxillary narrow, may be produced ...... Engraulidæ.
- b. Adipose fin present; photophores present; parietals absent.

STERNOPTYCHIDÆ.

## **ELOPIDÆ**

Body oblong or elongate, more or less compressed. Scales cycloid and silvery. Mouth large and terminal, bounded laterally by maxillaries which have two supplemental bones. Intermaxillaries short and nonprotractile. A gular plate present between mandibular branches. A straight lateral line present. Dorsal slightly behind origin of ventrals; anal far behind dorsal. Pectorals situated low and can be folded like ventrals. Gill rakers 13 to 30. Gill membranes free and separate. Branchiostegals numerous.

This family is represented in the collection by two genera, Elops Linnæus and Megalops Lacépède, each with one species.

In the genus *Elops*, large pseudobranchiæ are present; the dorsal and the anal are depressible in a scaly sheet; the dorsal is longer than the anal, without produced rays; the scales are small. In the genus *Megalops* no pseudobranchiæ are present; the dorsal and the anal are not provided with a scaly sheet; the dorsal is shorter than the anal, its last ray produced, and the scales are large and heavy.

## ELOPS HAWAIENSIS Regan. Bidbid, awa. Plate 1, fig. 11.

Elops saurus Bleeker, Atl. Ichth. 6 (1866-1872) 84; Macleay, Proc. Linn. Soc. N. S. W. 7 (1882) 594; Fowler, Proc. Acad. Nat. Sci. Phila. (1900) 496; Steindachner, Denk. Akad. Wiss. Wien 70 (1901) 513; Jenkins, Bull. U. S. Fish Comm. 22 (1902) 432; Evermann and Seale, Bull. U. S. Bur. Fish. 26 (1906) 53; Jordan and Richardson, Bull. U. S. Bur. Fish. 27 (1907) 235.

Elops hawaiensis REGAN, Ann. & Mag. Nat. Hist. III 8 (1909) 39; GÜNTHER, Journ. Mus. Godeffroy 8 pt. 16 (1910) 386; FOWLER, Proc. Acad. Nat. Sci. Phila. (1911) 204; WEBER, Fische Siboga Expeditie (1913) 1; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 3; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 256; Mem. B. P. Bishop Mus. 10 (1928) 26.

Elops hawaiiensis Fowler, Copeia No. 58 (June, 1918) 62; No. 112 (November, 1922) 82; Bull. B. P. Bishop Mus. 22 (1925); HERRE, Fish. Herre 1931 Philip. Exp. (1934) 13.

Head 3.4-3.7; depth 5.5-5.7; dorsal 23-24; anal 15-16; scales 94-97 in lateral line, 22-25 in transverse series, 10-12 above lateral line.

Body elongate, compressed. Head broad, about 3 in its length. Mouth large, oblique, inferior; jaws of equal length. Snout width about its length, equal eye. Maxillary narrow at origin, broad distally, greatest breadth about radius of eye; extends far behind hind margin of eye. Fine villiform teeth on jaws, entire inferior margin of maxillary, tongue, vomer, palatines, and pterygoids. Entire premaxillary teeth exposed when mouth is closed. Length of gular plate less than twice the orbit. Dorsal surface of head furrowed at center; interorbital less than eye. Radiating venules on preopercle and opercle. Four large, thin, soft scales behind occiput, the lateral pair overlapping opercle. About 30 branchiostegals, left wing overlapping right at isthmus. Gill rakers 13 to 15, hard, flattened, with spinous edge; length about equal to gill filament and to radius of eve. Pseudobranchiæ well developed, about 40. Scales minute, rather adherent, with 9 to 15 radii which terminate on basal margin on indentations; posterior margin serrate, crenulate. Scales on lateral line with closed tube on focus.

Origin of dorsal nearer caudal base than snout tip, depressible in scaly sheath; base about equal to postocular part of head, shorter than its height. Anal short, depressible in scaly sheath, shorter than height, slightly longer than greatest width of operculum, well advanced from caudal base. Pectorals equal dorsal base. Ventrals well developed, slightly shorter than pectorals, nearer anal than pectorals and below first fourth of dorsal base.

This description is based on two specimens, Nos. 15137 and 24349, 217 mm and 192 mm long, obtained from Manila December 9, 1926.

MEGALOPS CYPRINOIDES (Broussonet) Buanbuan, bulan-bulan. Plate 1, fig. 4.

Clupea cyprinoides BROUSSONET, Tableau Ichth. Lichtenstein, Forster, Descript. anim. (1844) 296.

Megalops indicus BLEEKER, Journ. Ind. Arch. 3 (1849) 67; KNER, Fische Novara Exp. (1865-67) 339.

Elops cundinga CANTOR, Journ. Asiat. Soc. Bengal 18 (1850) 1271.

Megalops macrophthalmus BLEEKER, Nat. Tijdschr. Ned. Ind. 1 (1851)

421.

Megalops cyprinoides Günther, Cat. Brit. Mus. 7 (1868) 471; Bleeker, Atl. Ichth. 6 (1866-72) 87; Day, Fishes of India 4°. (1878-88) 650; Sauvage, Hist. Madagascar 16 (1891) 495; Jordan and Seale, Proc. U. S. Nat. Mus. 18 (1905); Evermann and Seale, Bull. U. S. Bur. Fish. 26 (1906) 53; Günther, Fische der Südsee 8 (1909) 387; Weber, Fische Siboga Expeditie (1913) 1; Weber and de Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 5; Chaudhuri, Mem. Ind. Mus. 5 (1916) 417; Fowler, Copeia No. 58 (June, 1918) 62; Proc. Acad. Nat. Sci. Phila. 79 (1927) 256; Schmidt, Pan-Pacific Res. Inst. 5 No. 4 (1930) 2; Herre, Fish. Herre 1931 Philip. Exp. (1934) 13.

Megalops macropterus MACLEAY, Proc. Linn. Soc. N. S. W. 7 (1882) 594.

Clupea thrissocles SCHNEIDER, Bloch, Syst. Ichth. (1801) 424. Clupea setipinna VALENCIENNES, Hist. Nat. Poiss. 19 (1846) 286.

Head 3.3-3.6; depth 3.3-3.4; dorsal 17-19; anal 23-25; scales 34-36 in longitudinal series along lateral line; 12 in transverse series, 5 above lateral line; 15-17 predorsals.

Body oblong, compressed, ventral profile more convex than dorsal; belly noncultrate. Head width 2.3 to 2.4 in its length. Mouth large; lower jaw prominent, longer than upper; maxillary large, narrow at fusion with premaxillary, more or less uniformly broad posteriorly and ending bluntly on or slightly behind hind border of eye; length equals preocular part of head minus lower jaw. Snout short, about 1.4 in eye which is large and about 3.4 to 3.5 in head. Minute villiform teeth on jaws, along entire inferior border of maxillary, tongue, palatine, vomer, and pterygoid. Interorbital flat, narrower than snout, equal snout length. Branchiostegals 22 to 24, right wing rolled in, invariably overlapped by left wing at region of isthmus. Gill rakers 30 to 31, longer than filaments, less than radius of orbit, strong, flat, blunt, with spines on inner edge. Scales large, adherent, with peculiar lobate basal margin; with 4 to 8 prominent radii which end posteriorly on indentations of anterior margin; with several indistinct and broken transverse striations which may anastomose with radii; posterior margin thin, crenulate; scales on lateral line with large furrows on exposed portion radiating from foci.

Dorsal origin nearer caudal base than snout tip; last ray produced, not reaching caudal base, 1.7 to 2.2 times dorsal base which is about 1.5 in its height. Anal long, shorter than produced dorsal ray, longer than high; last ray barely reaching caudal base. Pectorals about equal anal base, 1.4 to 1.6 in head. Ventrals about equal dorsal base, nearer anal origin than pectorals, immediately below dorsal origin.

This description is based on No. 10048, 127 mm, obtained from Zambales, October 20, 1921, and No. 15141, 192 mm, obtained from Lake Bombon, Batangas, August 18, 1927.

Luzon, Cagayan Province, Buguey, No. 28186, 124 mm; Pampanga Province, Guagua, No. 15290, 181 mm, April 8, 1927; Macabebe, Nos. 15337, 28193-4, 168 to 183 mm, May 6, 1927; Tarlac Province, Tarlac, No. 4132, 223 mm, 1904; Zambales Province, Iba, No. 10048, 130 mm, October 20, 1921; Bulacan Province, Obando, sitio Pagogo, No. 15335, 143 mm, April 2, 1927; Paombong, No. 15336, 15 mm, April 22, 1927; Rizal Province, Pasay, No. 543, 162 mm, July 7, 1907; Manila, Nos. 302, 162 mm, June 14, 1907; No. 950, 207 mm, September, 1907; Albay Province, Legaspi, Rawis River, Nos. 13075 and 28288-89, 35 to 79 mm, February 2-3, 1926. MINDORO, Mindoro Province, Mangarin Bay, No. 9645, 128 mm, 1913; Puerto Galera, Nos. 10079, 28188-89, 110 to 140 mm, March-May, 1912. GUIMARAS, Iloilo Province, Jordan, Nos. 11630, 28187, 80 to 86 mm, February 7, 1925. NEGROS, Negros Oriental Province, Dumaguete, No. 15971, 55 mm, March, 1913. PALAWAN, Palawan Province, Taytay, Nos. 10079, 28190-92, 90 to 175 mm, May, 1913. BALABAC, Palawan Province, No. 15697, 168 mm, November 17, 1927. CAMIGUIN, Misamis Province, No. 583, 202 mm, July 20, 1907.

# ALBULIDÆ

Body elongate, slightly compressed; abdominal surface rounded, not keeled. Head naked. Snout prominent, conical, long, projecting beyond cleft of mouth which is inferior and horizontal. Maxillary edentulous with one supplemental bone. Villiform teeth on jaws, vomer, and palatines; granular teeth on pterygoids, sphenoid, and tongue. Eye large, with broad annular adipose covering. Gular plate wanting. A collar of thin, flappy scales on occiput. Gill membranes separate, free from isthmus. Gill rakers short, granular. Scales small, ad-

herent, cycloid, with a brilliant silvery sheen. Lateral line present. Dorsal slightly in advance of ventrals. Anal short, less than base of dorsal, far behind anus. Caudal deeply forked. Large axillary scales above and below ventrals. Branchiostegals 11 to 16. Pseudobranchiæ well developed.

## Genus ALBULA Bloch

For characters of the single genus see those of the family. One Philippine species is known.

## ALBULA VULPES (Linnæus). Plate 1, fig. 12.

Esox vulpes LINNÆUS, Syst. Nat. ed. 10 (1758) 313.

Argentina glossodonta Forskål, Descript. anim. (1777) 68; BONNATERRE, Ency. Ichth. (1752-1804) 177; GMELIN, Linn. Syst. Nat. (1748-1804) 1394.

Esox argenteus Schneider, Bloch, Syst. Ichth. (1801) 395; Lichten-Stein, Forster, Descript. anim. (1844) 196, 256.

Synodus argenteus Schneider, Bloch, Syst. Ichth. (1801) 398.

Clupea Brasiliensis SCHNEIDER, Bloch, Syst. Ichth. (1801) 427.

Amia immaculata Schneider, Bloch, Syst. Ichth. (1801) 451.

Butirinus bonanus Lacépède, Hist. Nat. Poiss. 5 (1803) 45; CUVIER and VALENCIENNES, Hist. Nat. Poiss. 18 (1848) 345.

Argentina sphyraena LACÉPÈDE, Hist. Nat. Poiss. 5 (1803) 366.

Clupea macrocephala LACÉPÈDE, Hist. Nat. Poiss. 5 (1803) 426, 428, 460.

Butirinus glossodontus RÜPPELL, Neue Wirbelthiere, Fische (1835–1840) 80; TEMMINCK and SCHLEGEL, Fauna Japon. Poiss. (1842) 242, GÜNTHER, Fish. Zanzibar (1866) 120.

Conorhynchus glossodon BLEEKER, Atl. Ichth. 6 (1866-1872) 83; Versl. Akad. Ams. 2 II, pt. 2 (1868) 300.

Albula conorhynchus Cuvier and Valenciennes, Hist. Nat. Poiss. 19 (1848) 356; GÜNTHER, Cat. Brit. Mus. 7 (1868) 468; Day, Fishes of India 4°. (1878–1888) 648; STREETS, Bull. U. S. Nat. Mus. 7 (1877) 76; SCHMELTZ, Cat. Mus. Godeffroy 6 (1877) 18; GÜNTHER, Rept. Voyage "Challenger" 1 (1880) 66; MACLEAY, Proc. Linn. Soc. N. S. W. 7 (1882) 593; 8 (1883) 278.

Albula neoguinaica Cuvier and Valenciennes, Hist. Nat. Poiss. 19 (1846) 253.

Albula seminuda CUVIER and VALENCIENNES, Hist. Nat. Poiss. 19 (1846) 254.

Albula erythrocheilus Cuvier and Valenciennes, Hist. Nat. Poiss. 19 (1846) 254; Cantor, Journ. Asiat. Soc. Bengal. 18 (1850) 283.

Albula forsteri CUVIER and VALENCIENNES, Hist. Nat. Poiss. 19 (1846) 256.

Albula bananus Cuvier and Valenciennes, Hist. Nat. Poiss. 19 (1846) 249; Bleeker, Ichth. Madura, Verh. Bat. Gen. 22 (1849) 11; Kner, Fische Novara Exp. (1865–1867) 339.

Albula glossodonta Klunzinger, Fische Rothen Meeres, Verh. z. b. Ges. Wien (1871) 602; Steindachner, Denk. Akad. Wiss., Wien 70 (1901) 513.

Albula vulpes SEALE, Occ. Papers, B. P. Bishop Mus. 1 No. 2 (1902) 15, 18; JENKINS, Bull. U. S. Fish. Com. 22 (1902) 432; SNYDER, Bull. U. S. Fish Comm. 22 (1902) 521; JORDAN and EVERMANN, Bull. U. S. Fish. Comm. 23 pt. 1 (1903) 55; SEALE, Occ. Papers B. P. Bishop Mus. 4 No. 1 (1906) 5; KENDALL and GOLDSBOROUGH, Mem. Mus. Comp. Zool. 26 (1911) 242; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 7; McCulloch, Rec. Austr. Mus. (1919) 172; FOWLER, Bull. B. P. Bishop Mus. 22 (1925) 4, 23; FOWLER and BALL, Bull. B. P. Bishop Mus. 26 (1925) 5; FOWLER, Bull. B. P. Bishop Mus. 38 (1927) 5; Mem. B. P. Bishop Mus. 10 (1928) 27; SCHMIDT, Pan-Pacific Res. Inst. 5 No. 4 (1930) 2.

Albula glossodon Günther, Fische der Südsee 3 (1909) 385. Albula virgata Jordan and Jordan, Mem. Carnegie Mus. 10 (1922) 6.

Head 3.4-3.7; depth 4.3-4.6; dorsal 17; anal 7; scales 66-71 along lateral line, 6-7 behind caudal base; 17-18 on transverse series below origin of dorsal, 9 above lateral line, 25-27 predorsals.

Body elongate, slightly compressed, sometimes subcylindrical. Dorsal profile more convex than ventral, latter sometimes nearly straight. Caudal peduncle slightly compressed, length about equal to its least width, 4 in head. Head conical, terminating acutely. Snout prominent, heavy, long, 2.5 in head, broad behind, narrow anteriorly, greatest breadth 1.2 in its length. Maxillary barely reaches front margin of eye, slightly less than length of snout, superior portion hidden below preopercle, inferior portion thick with adipose tissue, exposed. Lower jaw pointed, not prominent, shorter than upper jaw, wedged between maxillaries. Villiform teeth on jaws, vomer, and palatines; strong, granular teeth on tongue, pterygoids, and sphenoid; the toothed portion of tongue elevated, wedged between protruding pterygoids and depressed sphenoid. Eye 5.4 in head, with thick adipose eyelid. Top of head wide, flat, straight, descending, covered with thick adipose membrane; tuberculate at posterior portion. Interorbital wide, 1.3 times orbit. Radiating venules on preopercle originating from posterior margin of eye. Cheek and preorbital with fine tubercles. Inferior margin of cheek immediately behind maxillary, lined with 7 to 9 subcircular scales, which are firmly attached to each other, smaller than body scales, with a central focus; anterior margin indented with two radii; anterior portion tuberculate. An occipital collar of thin, soft, scales, those on extreme lateral sides partly overlapping edge of opercular opening. Gill rakers 8 to 9, reduced to knob-shaped structure; gill filaments about 1.4 in head. Pseudobranchiæ about 40. Branchiostegals 13. Scales adherent, regularly arranged, rather small, unimbricated portion silvery, with thin, wide, flabby, crenulate membrane bordering on smoothly convex hind margin; anterior margin more or less straight, with 4 to 6 prominent indentations, 2 to 4 radii arising from focus; posterior portion with horizontal rows of minute, pearly tubercles which lose linear arrangement toward focus. Scales on lateral line with convexity of posterior margin disturbed by the single lateral line tube. Lateral line nearly straight.

Dorsal origin about midway between snout tip and caudal base; base slightly shorter than height, which equals head minus snout; rays with a flap of scales each, which overlaps succeeding ray behind, partly imbricating next scaly flap. Anal small, base shorter than height, slightly longer than orbit. Pectorals well developed, about equal base of dorsal, extend slightly in front of origin of dorsal. Ventrals equal snout, with well-developed superior and inferior axillary scales. Membranes between rays of pectorals, ventrals, and anal with small, silvery scales.

Brilliant silvery all over. Dorsal portion of head light brown. A brownish black spot in front of nostril; a transverse band of similar color before tip of snout.

This description is based on No. 16219, 285 mm, collected from Cadiz Nuevo, Occidental Negros, August, 1929.

The only other specimen of the species in the collection (No. 16002), was obtained by S. T. Trawler "Los Pescados" from Mekong River, Tibet, in southern Asia.

## CHANIDÆ

Body oblong, somewhat compressed, head depressed. Scales cycloid, small, adherent, longitudinally striped. Mouth terminal, small, and bordered above only by the intermaxillaries. Maxillaries without supplemental bone. Mandibles with a symphysial tubercle which fits into a notch between the intermaxillaries. Teeth absent. Dorsal opposite ventrals, which are longer than anal. Ventrals well developed, with 11 or 12 rays. Caudal forked. Gill membranes totally united, free from isthmus; 4 branchiostegals; pseudobranchiæ well developed; gill rakers in two diverging rows, very fine and numerous.

This family is represented by *Chanos chanos* Forskål, the only species in the Philippines.

CHANOS CHANOS (Forskål). Bañgos. Plate 1, fig. 3.

Mugil chanos Forskål, Descript. anim. (1775) 14, 74.

Mugil salmoneus (Forster) (SCHNEIDER, Bloch, Syst. Ichth. (1801) 421; LICHTENSTEIN, Forster Descript. anim. (1884) 299.

Chanos cyprinella EYDOUX and SOULEYET, Voy. "Bonite" Zool. 1 (1841) 196.

Chanos oriental Eydoux and Souleyet, Voy. "Bonite" 1 (1841) 196. Chanos salmoneus Cuvier and Valenciennes, Hist. Nat. Poiss. 19 (1846) 146; Bleeker, Arch. Neerl. Sci. Nat. 13 (1878) 38; Günther, Rep. Voyage "Challenger" 1 (1880) 61; Macleay, Proc. Linn. Soc. N. S. W. 7 (1882) 594; Valllant, Bull. Soc. Philom. Paris VII 11 (1886-87) 53.

Chanos chloropterus KNER, Novara Exp. Fische 1 pt. 5 (1865) 341. Chanos orientalis SCHMELTZ, Cat. Godeffroy Mus. 4 (1869) 25.

Chanos chanos Steindachner, Denk. Akad. Wiss., Wien. 70 (1901) 514; Jenkins, Bull. U. S. Fish Comm. 22 1902 (1903) 432; Jordan and Schneider, Proc. U. S. Nat. Mus. 28 (1904) 124; Jordan and Evermann, Bull. U. S. Fish Comm. 23 pt. 1, 1903 (1905) 56; Jordan and Seale, Bull. U. S. Bur. Fish. 25 (1905) 186; 26 (1906) 4; Jordan and Richardson, Bull. U. S. Bur. Fish. 27 (1907) 236; Evermann and Seale, Proc. U. S. Nat. Mus. 31 (1907) 505; Seale and Bean, Proc. U. S. Nat. Mus. 33 (1907) 239; Günther, Journ. Godeffroy Mus. 8 pt. 16 (1909) 387; Kendall and Goldsborough, Mem. Mus. Comp. Zool. 26 (1911) 243; Weber and De Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 15; Chaudhuri, Mem. Indian Mus. 5 (1916) 417; Fowler, Bull. B. P. Bishop Mus. 22 (1925) 23; 38 (1927) 5; Fowler, Proc. Acad. Nat. Sci. Phila. 79 (1927) 256; Schmidt, Pan-Pacific Res. Inst. 5 No. 4 (1930) 3.

Head 3.8-4; depth 3.4-3.8; dorsal 12-13; anal 8; scales 76-82 in median lateral line series; 32-36 in transverse series; 31-34 predorsals.

Body moderately elongated and compressed; dorsal profile slightly more convex than ventral which is rounded, broadened, especially on thoracic portion. Caudal peduncle rather long, about 2.3 in head, greater than least depth. Head width greater than twice length. Snout width greater than its length, equals eye diameter, undershot to a conical point. Eye large, twice nearer to snout tip than to posterior margin of operculum, 3.2 to 3.5 in head, with thick adipose eyelid. Mouth small; maxillary barely reaching front margin of eye, partly hidden below preorbital, toothless. Lower jaw slightly shorter than upper jaw, tightly wedged between rami of maxillary. Vertex low, concave, broad, greater than greatest diameter of eye, less than 3 in head; often covered with a thick adipose membrane. Nape

high, greatly convex, broad. Gill membranes completely united below. Branchiostegals 4, cemented together. Gill rakers 240 to 252, lanceolate, slender, smooth, short, one-third of gill filament, which is longer than half orbit. Scales regularly imbricated, strongly adherent, small, with length slightly greater than width; basal margin with a deep, cuneiform notch at middle portion; 25 to 39 longitudinal striæ on unimbricated portion, which terminate at posterior margin where each forms the pinnacle of serrature; focus central, distinct; circuli fine, circularity disturbed by basal notch to which they conform; discontinuous due to posterior striæ; no transverse striations. Lateral line straight except for anterior part which rises to summit of operculum.

Dorsal origin equidistant from front margin of orbit and caudal base; base sheltered in flaps of two rows of alar scales, 1.5 in length of longest ray which is 3 in distance of dorsal origin to snout tip, last ray much branched, ultimate branch longest. Caudal deeply forked, lobes much longer than head; directed slightly upward. Pectorals 1.5 in head; first ray large, strong, origin overlapped by margin of gill membrane. Ventrals well developed, slightly smaller than pectoral, equal dorsal base, 1.8 in head; origin nearer pectorals than caudal, base about below middle of dorsal; axillary scale well developed, tapers posteriorly, 1.7 in ventrals. Anal short, base less than height, about a snout length, somewhat protracted; rays, for a large part, enveloped in scaly sheaths.

Description based on Nos. 307 (261 mm) and 639 (307 mm) from Manila market, June 17 and August 4, 1927, respectively. Luzon, Pampanga Province, Macabebe, No. 15414, 125 mm, May 6, 1927; Macabebe, No. 21155, 168 mm, May 6, 1927; Rizal Province, Malabon, Dampalet, Nos. 15264, 21158-62, 34-38 mm, May 8, 1927; Malabon, Tonsuya, No. 15245, 161 mm, March 30, 1927; Malabon, Nos. 21165-70, 43-55 mm, April 17, 1928; Manila, Manila market, No. 55393, 298 mm, July 8, 1927; Manila market, No. 951, September, 1907: Cavite Province, Cavite, Nos. 26993-97, 49-65 mm, September 27, 1927. PANAY, Iloilo Province, Dumangas, Nos. 15485, 21154, 176 and 218 mm, August 3, 1927; Jaro, No. 45481, 124 mm, August 14, 1927. BANTAYAN. Cebu Province, No. 5922-23, 111-125 mm, May, 1909. Cebu Province, Opon, No. 15443, 169 mm, August 27, 1927. ВоноL, Bohol Province, Kagtong, No. 14804, 143 mm, November 25, 1926. PALAWAN, Palawan Province, Panacan, Paragua. Nos. 5311, 21164, 226 mm, August 14, 1908. Bungau, Sulu Province, Bungau, Nos. 21156-57, 10779, 59-80 mm, September 7, 1923.

## CHIROCENTRIDÆ

Body very long and compressed. Scales thin, small, and very deciduous. Abdomen with sharp margin but without scutes. Mouth large, very oblique, bordered by large intermaxillaries and long narrow maxillaries with two supplemental bones. Mandibulars very prominent, teeth on mandibulars and median portion of intermaxillaries caninoid; those in other parts of the jaws are long and pointed, few teeth on palatines and tongue. Eyes small, subcutaneous. Dorsal above anterior part of very long anal. Ventrals very small, midway between caudal base and tip of snout. Pectorals situated low, folding like ventrals. Gill membranes separate, free; branchiostegals 8; gill rakers very short, strong, flattened, 13; no pseudobranchiæ.

This family is represented in the Philippines by one genus.

## Genus CHIROCENTRUS Cuvier

The characters of the genus are the same as those of the family. One Philippine species is known.

# CHIROCENTRUS DORAB (Forskål). Parang-parang. Plate 1, fig. 9.

 Clupea dorab Forskål, Descript. anim. (1775) 72; Cuvier and Va-LENCIENNES, Hist. Nat. Poiss. 19 (1846) 110; Jouan, Mem. Soc. Cherbourg 18 (1861) 306; 21 (1877-78) 335.

Chirocentrus dorab Bleeker, Atl. Ichth. 6 (1866-72) 92, 271; Bleeker, Versl. Akad. Amsterdam 2 ser. II (1868) 300; Peters, Monatsb. Akad. Wiss. Berlin 1876 (1877) 846; Macleay, Proc. Linn. Soc. N. S. W. 7 (1882) 594; Jordan and Seale, Bull. U. S. Bur. Fish. 26 (1906) 4; Evermann and Seale, Bull. U. S. Bur. Fish. 26 (1906) 53; Jordan and Richardson, Bull. U. S. Bur. Fish. 27 (1907) 236; Günther, Journ. Godeffroy Mus. 8 pt. 16 (1909) 388; Weber and De Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 18; Fowler, Copeia No. 58 (June, 1918) 62; Fowler and Bean, Proc. U. S. Nat. Mus. 62 (1922) 2; Fowler, Proc. Acad. Nat. Sci. Phila. 79 (1927) 256.

Head 5.7; depth 6; dorsal 16; anal 30. Body very elongate, strongly compressed; depth almost uniform from insertion of pectorals to anal; ventral profile sharp, nonserrate, with hairlike appendages in a single row from pectorals to anal. Caudal peduncle long, deep, length slightly greater than least depth, 2 in head measured from tip of lower jaw. Head small, well compressed, width 3.6 in its length, directed dorsally and anteriorly

so that the tip of snout rises above level of dorsal profile; shallow notch at junction of nape and vertex. Mouth large, oblique; lower jaw well protracted, longer than upper jaw. Maxillary reaches to below middle of eye; upper lip fold produced anteriorly into a small mesial flap which ends acutely and finds support on a pair of horizontal, sharp canines on the small pre-Entire margin of maxillary armed with small, firm, maxillary. sharp, teeth which become smaller and closely set towards posterior edge. Six to nine pairs of canine teeth on mandible, directed posteriorly, compressed. sharp. slightly upward. Tips of maxillary and mandible do not meet, leaving mouth slightly gaping and leaving first three to five pairs of mandibular canines and the single pair of maxillary canines exposed. Snout greater than orbit, less than four times head with lower Teeth on palatine, pterygoid, and tongue. Eye slightly Interorbital flat, about one orbit. Cheek, preopercle, and postorbital with extensive venation. Gill opening wide. Branchiostegals small, well hidden inside rami of mandible. Gill rakers 14, short, flat, blunt, toothed on inside edge, widely spaced, shingled flat on arch, about half filament which is shorter than orbit. Scales small, very deciduous, entire, regular, with fine circuli, without transverse striations. low, situated far back, about 2.5 nearer to caudal base than to snout tip; slightly in front of anal which is long, more than twice dorsal base. Pectorals well developed, 1.4 in head, less than twice anal base; first ray strong, stout, compressed, with flat sides at right angle with body; ventral and dorsal axillary scales well developed. Dorsal 1.5 in pectorals. Ventrals much reduced, less than orbit; 1.6 nearer to anal origin than to pectorals; axillary dorsal scale longer.

The above description is based on No. 11597, 406 mm, obtained from Manila, December 23, 1924.

LUZON, La Union Province, Rabon, Rosario, Nos. 12482, 14334, 190 and 341 mm, July 27, 1925: Pangasinan Province, San Fabian, No. 4180, 354 mm, 1904: Manila, Manila market, No. 559, 295 mm, July, 1907; No. 11674, 282 mm, February 23, 1925: Camarines Sur Province, San Miguel Bay, No. 9524, 352 mm, December 19, 1918; Caiabanga, Nos. 11578, 13219, 21174−5, 237−277 mm, January 16, 1926; San Miguel, Nos. 21176−7, 166−257 mm, December 19, 1918. Tablas, Romblon Province, Tablas, Nos. 10149, 21173 and 162, 174 mm, January, 1923. SAMAR, Samar Pr∪vince, Buguey, No. 14796, 322 mm, December

6, 1926. Panay, Iloilo Province, Dumangas, No. 10118, 239 mm, June 2, 1922; Estancia, No. 10439, 248 mm, June 2, 1922; No. 10859, 246 mm, July, 1922; No. 11765, 202 mm, February 11, 1925: Antique Province, Culasi, No. 41121, 66 mm, December 15, 1933. Guimaras, Iloilo Province, West Coast Guimaras Island, Nos. 41332, 41334, 113 and 125 mm, December 18, 1933. Leyte, Leyte Province, Tacloban, No. 1187, 372 mm, September 4, 1907; Carigara, No. 7892, 253 mm, December 13, 1913. Bantayan, Cebu Province, Bantayan, No. 5559, 512 mm, April, 1909. Mindanao, Davao Province, Davao, No. 3228, 148 mm, April 21, 1908. Basilan, Sulu Province, Basilan, No. 10781, 339 mm, August, 1923.

We have the following foreign examples: Hongkong, No. 6245, 189 mm; No. 6258, 134 mm; No. 6265, 149 mm, August, 1910.

# **DUSSUMIERIIDÆ**

More or less elongate fishes with rounded belly. Scales moderate or large, thin, deciduous. Abdominal scutes absent. Head more or less pointed. Mouth small, terminal bordered by the small intermaxillary and the long maxillary which has two supplemental bones. Jaws equal or nearly so. Teeth small, on jaws, vomer, palatines, pterygoids, and tongue, deciduous and may be wanting. Dorsal longer than anal, inserted opposite ventral. Gill membranes separate, free from isthmus; 6 to 15 branchiostegals. Gill rakers few, very fine, slender. Pseudobranchiæ present.

Key to the Philippine genera of the Dussumieriidæ.

## Genus SPRATELLOIDES Bleeker

Body small, elongate, nearly subcylindrical. Tail short, scales large, thin, deciduous. Snout conical, jaws equal, cleft of mouth small. Dorsal short, its origin nearer end of snout than caudal base. Branchiostegals flat, 6; pseudobranchiæ well developed; gill rakers rather long.

Key to the Philippine species of Spratelloides.

- a. Scales 35 or 36 in median lateral series; anal 9.
  - S. delicatulus (Bennett).
- a. Scales 45 in median lateral series; anal 13........... S. gracilis (Schlegel).

# SPRATELLOIDES DELICATULUS (Bennett).

Clupea delicatula Bennett, Proc. Comm. Zool. Soc. 1 (1831) 168.
Clupea macassariensis Bleeker, Journ. Ind. Arch. 3 (1849) 72.
Clupeoides macassariensis Bleeker, Verh. Bat. Gen. 24 (1852) 17.
Spratelloides delicatulus Günther, Cat. Brit. Mus. 7 (1868) 464;
Bleeker, Atl. Ichth. 6 (1866-1872) 96; Schmeltz, Cat. Mus. Godeffroy 5 (1874) 37; Günther, Fische der Sülsee 3 (1909-1910) 383.
Stolephorus delicatulus Jordan and Seale, Bull. U. S. Bur. Fish. 25 (1906) 186; Evermann and Seale, Bull. U. S. Bur. Fish. 26 (1906) 53; Seale, Occ. Papers B. P. Bishop Mus. 4 No. 1 (1906) 5; Kendall and Goldsborough, Mem. Mus. Comp. Zool. 25 (1911) 243; Fowler, Occ. Papers B. P. Bishop Mus. 8 No. 7 (1923) 375; Bull. B. P. Bishop Mus. 22 (1925) 4; Fowler and Ball, Bull. B. P. Bishop Mus. 26 (1925) 5; Fowler, Proc. Acad. Nat. Sci. Phila. 79 (1927) 256; Mem. B. P. Bishop Mus. 10 (1928) 29.

Head 4-4.4; depth 5.3-6; dorsal 11-12; anal 9-10; scales 35-37 on median lateral series, 7-8 on transverse series; predorsals 12-14.

Body elongate, moderately compressed; dorsal and ventral sides rounded. Snout conical, longer than eye which is about 4 Maxillary reaches to front margin of eye. Interorbital less than eye, flat, nonvenulose. Prominent venules on cheek, preopercle, and opercle; characteristic black venules on preorbital just behind superior margin of maxillary. rakers 22 to 26, finely lanceolate, slightly longer than gill filaments, shorter than eye. Scales deciduous, with 3 to 7 transverse striæ, all continuous, regular, posterior margin sometimes slightly and irregularly serrate. Dorsal origin nearer snout tip than caudal base; base depressed, much shorter than height, which equals head minus snout. Anal low, short, inserted about midway between caudal base and ventral origin. Pectorals slightly longer than postocular part of head, not reaching ventral, which is longer than eye and inserted below middle of dorsal, midway between pectorals and anal.

The above description is based on the 2 largest of 25 specimens bearing No. 2975, ranging in size from 31 to 53 mm, collected from Bacon, Sorsogon, 1904.

# Genus DUSSUMIERIA Cuvier and Valenciennes

Body rather elongate, more or less compressed; abdomen rounded, not serrate. Scales of moderate size, deciduous; no lateral line. Snout pointed; upper jaw not projecting; cleft of mouth of moderate width. Form of mouth like that of *Clupea*. Jaws with small, fixed, nondeciduous teeth; patches of villiform

teeth on palatine, pterygoid, and tongue, but absent from vomer. Dorsal fin opposite ventral; anal moderate in length. Gill membrane with numerous very fine branchiostegals; pseudobranchiæ well developed.

Key to the Philippine species of Dussumieria.

- a. Scales 40 to 42 in median lateral series.
- D. acuta Cuvier and Valenciennes. a. Scales 52 to 56 in median lateral series............ D. hasseltii (Bleeker). DUSSUMIERIA ACUTA Cuvier and Valenciennes. Tulis. Plate 1, fig. 5.

Dussumieria acuta Cuvier and Valenciennes, Hist. Nat. Poiss. 20 (1847) 343; Cantor, Journ. Asiat. Soc. Bengal 18 (1850) 1268; Kner, Fische Novara Exp. (1865–1867) 330; Günther, Cat. Brit. Mus. 7 (1868) 466; Day, Fish. Malabar (1865) 226; Bleeker, Atl. Ichth. 6 (1866–1872) 647; Macleay, Proc. Linn. Soc. N. S. W. 8 (1883) 278; Weber and De Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 21; Fowler and Bean, Proc. U. S. Nat. Mus. 62 art. 2 (1923) 2; Fowler, Mem. B. P. Bishop Mus. 10 (1928) 30; Derani-Yagala, Spolia Zeylanica 15 (1929) 33; Ceylon Journ. Sci. 5 (1833) 82.

Dussumieria elopsoides BLEEKER, Ichth. Madura, Verh. Bat. Gen. 22 (1849) 12; Versl. Akad. Ams. 2 ser. II (1868) 300; JORDAN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 5; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236.

Dorsal 19-22; anal 14-17; pectoral 14-15; ventral 8; scales in median lateral series 40-42; scales in transverse series 11-12; head 3.5-3.8; depth 4.1-4.6; predorsal scales 18-19; pre- and postventral scutes indistinct.

Body elongate, moderately compressed, fusiform, dorsal and ventral profile evenly convex; symphysis to ventral fin evenly convex, dorsal profile of head with vertex straight. Caudal peduncle moderately compressed, least depth 1.5 to 3 in its length. Head width 1.6 in its length; snout width 1.2 in its length, 2.3 to 3 in head. Eyes 3.6 in head. Lower jaw longer and more prominent than upper. Maxillary 2.3 in head not reaching below front margin of eye. Teeth on jaws, tongue and palate, but not on vomer. Interorbital flat, slightly concave. with a ridge at middle, 4.3 in head; no venation on vertex. Cheek without large prominent striæ; no venation on post-, pre-, and subopercle. Gill rakers 22 to 24, finely lanceolate, with very fine spines along inner side, about 2 in eye, practically equal to branchial filaments in length. Scales thin, deciduous, their hind margin indistinctly crenulate. Elongated scales on axil of pectorals and ventrals. Scales with 9 striæ, all broken; circuli fine, parallel.

Dorsal depressible in scaly sheaths, its origin much nearer to caudal than to tip of snout, its branched ray 2 to 2.5 in head. Caudal deeply forked. Pectoral depressible in basal scaly flaps, 1.5 in head; ventral 2 in pectoral; axillary ventral scale from 2.3 to 2.5 in pectoral. Ventral inserted beneath last half of dorsal; ventral 2.5 to 3 in head. Origin of anal far behind dorsal, about as long as postorbital part of head, shorter than ventrals; ultimate anal ray well developed.

This description is based on No. 89, 83 mm, and No. 6862, 130 mm, from Manila market, June 10, 1910.

Luzon, Bataan Province, Orani, No. 23967, 52 mm, April 29, 1923; Manila, Manila market, No. 61, 118 mm, May 25, 1907; Nos. 89-91, 82-108 mm, May 31, 1907; No. 159, 110 mm, June 7, 1907; Nos. 6858-59, 117 mm, June, 1910; Nos. 6860-68, 85-130 mm, June, 1910; No. 21241, 65 mm, June, 1910.

## DUSSUMIERIA HASSELTII Bleeker. Tulis. Plate 1, fig. 2.

Dussumieria hasseltii BLEEKER, Nat. Tijdschr. Ned. Ind. 1 (1851) 422;
Verh. Bat. Gen. 24 (1852) 13; Atl. Ichth. 6 (1866-1872) 95; DAY,
Fishes of India 4°. (1878-1888) 647; JORDAN and RICHARDSON, Bull.
U. S. Bur. Fish. 27 (1907) 236; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 23; FOWLER, Copeia No. 58 (June, 1918) 62;
Proc. Acad. Nat. Sci. Phila. 79 (1927) 256.

Dussumieria elopsoides Günther, Cat. Brit. Mus. 7 (1868) 466 (nec Bleeker); JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236.

Dorsal 18-20; anal 16; pectoral 14-15; ventral 8; scales 52-56 in median lateral series; 12-13 in transverse series; head 3.3 3.6; depth 4.1-4.5; predorsal scales 18-21; pre- and postventral scutes indistinct.

Body elongate, more or less compressed, fusiform; dorsal and ventral profile evenly convex; symphysis to ventral fin convex. Caudal peduncle moderately compressed, its least depth 1.5 in its length; 3 in head. Head width 1.5 in its length; snout width equal length, about 3 in head. Eye about 3.5 to 4 in head. Lower jaw longer and more prominent than upper. Maxillary nearly reaching below front margin of eye, 2.3 to 2.5 in head; teeth on jaw, palatines, pterygoids, and tongue. Interorbital flat, slightly concave with a ridge at middle, 4.5 in head, vertex without venation. Cheek without large prominent striæ, and no venation on post-, pre-, and subopercle. Gill rakers 22 to 24, finely lanceolate, with very fine spines along inner side, about 2.1 in eye, slightly longer than branchial filaments; pseudo-

branchiæ 19. Scales thin, deciduous, crenulate, and entire, with 11 to 15 striæ, 2 to 8 unbroken; circuli fine, elongate scales at axil of pectorals and ventrals. Origin of dorsal more than eye diameter nearer caudal than snout. Dorsal depressible in basal scaly sheaths, the first branched ray 3 in head. Caudal deeply forked. Pectoral depressible in basal scaly flaps, 1.6 to 2 in head; ventral 2; axillary ventral scale 2 to 2.3. Origin of ventral below middle of dorsal, 1.4 in head. Origin of anal far behind dorsal as long as postorbital part of head, shorter than ventral; ultimate ray well developed.

The above description is based on No. 21262, 117 mm, obtained from Barrio Sibubu, Camarines Sur, January 17, 1926.

LUZON, La Union Province, Rosario, Barrio Rabon, No. 12456, 84 mm, July 25, 1925; Tayabas Province, Unisan, Nos. 14850, 21216–17, 75–78 mm, February 15, 1924: Camarines Sur Province, San Miguel Bay, No. 11687, 122 mm, November 11, 1924; Nos. 21225–29, 93–103 mm, July 11, 1924; Barrio Sibubu, Nos. 13241, 21260–64, 112–122 mm, January 17, 1926. SAMAR, Samar Province, San Pedro Bay, near Basey, Nos. 12364, 21230–34, 111–114 mm, September 17, 1925. PANAY, Antique Province, Culasi, Nos. 41117, 41309–10, 88–109 mm, December 15, 1933. Guimaras, Iloilo Province, west side of Guimaras Island, Nos. 41312–13, 43–74 mm, December 10, 1934.

## DOROSOMIDÆ

Body short, deep, strongly compressed. Scales thin, more or less adherent. Abdominal scutes keeled, spiny. Snout conical, prominent, mouth small, inferior, bordered by intermaxillaries only; maxillaries narrow, with one supplemental bone; no teeth. Eye with adipose eyelid. Dorsal opposite ventrals; anal rather long; pectorals and ventrals moderate; caudal forked. Gill membranes separate, free; branchiostegals 5 to 6; gill rakers short, slender, numerous; pseudobranchiæ large.

# Key to the Philippine genera of the Dorosomidæ.

- a \*. Edge of dentary reflected outward at angle of mouth, before end of maxillary.

  - b . Last dorsal ray not prolonged into a filament; maxillary a straight, thin, transversely expanded plate, tapering........... Anodontostoma.

## Genus NEMATALOSA Regan

Mouth toothless, subterminal or inferior, transverse, its cleft forming an angle; dentary edge reflected outwards in front of end of maxillary; one supplemental maxillary bone present; scales 44 to 50 in median lateral series, 14 to 21 in transverse series; dorsal rays 13 to 18; anal 18 to 24; ventral with 8 rays, below or little before dorsal.

There is one Philippine species of this genus.

NEMATALOSA NASUS (Bloch). Suagan. Plate 1, fig. 1; Plate 3, fig. 2.

Clupea nasus Bloch, Ausl. Fische 9 (1795) 116.

Chatoessus nasus Cuvier and Valenciennes, Hist. Nat. Poiss. 21 (1848) 76; Bleeker, Verh. Bat. Gen. 24 (1852) 50; Günther, Cat. Brit. Mus. 7 (1868) 407; Day, Fishes of India 4°. (1866-72) 142; Ramsay and Ogilby, Proc. Linn. Soc. N. S. W. 1 (1886) 8. Chatoessus selangkat Kner, Novara Exp. Fische (1865-67) 337 (nec Bleeker).

Dorosoma nasus Bleeker, Atl. Ichth. 6 (1866-72) 142; Weber and De Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 24; Deraniyagala, Spolia Zeylanica 15 (1929) 45.

Konosirus thrissa Jordan and Seale, Proc. Davenport Acad. Sci. 10 (1905) 2 (not Clupea thrissa Linnæus); EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 54; HERRE, Fish. Herre 1931 Philip. Exp. (1934) 15.

Konosirus nasus Jordan and Herre, Proc. U. S. Nat. Mus. 31 (1906) 625; Seale and Bean, Proc. U. S. Nat. Mus. 33 (1907) 239.

Clupanodon thrissa FOWLER, Mem. B. P. Bishop Mus. 10 (1928) 32. Nematalosa nasus HERRE, Fish. Herre 1931 Philip. Exp. (1934) 15.

Head 4-4.2; depth 2.2-2.3; dorsal 15-17; anal 21-23; scales 40-45 in median lateral series; 18-19 in transverse series; 18 predorsals; abdominal scutes, 18 preventral, 11-12 postventrals.

Body oblong, deep, strongly compressed; belly cultrate, lined by spinous and firm scutes which become less trenchant anteriorly. Profiles greatly convex, dorsal uniform; ventral acute from pectorals to anal. Head small, width about 1.7 its length; snout shorter than eye which is 3.3 to 3.5 in head. Maxillary slender, expanded terminally and curved downward, its greater portion hidden beneath preorbital and premaxillary; reaches to below middle of pupil. Interorbital wide, equals eye; tuberculate, slightly convex; with a slightly prominent keel; margin of vertex finely serrate; venules on cheek and preopercle. Gill rakers 135 to 139; very finely lanceolate, smooth, 1.4 in gill filaments, about 3 in head. Pseudobranchiæ prominent, 22 to 25. Scales adherent, wider than long; with one characteristic transverse continuous stria, which may be wavy; posterior margin serrate with indistinct crenulations; basal margin smooth.

Dorsal origin nearer snout than caudal base; base submerged in scaly sheaths, less than height, last ray in adult prolonged along dorsal margin reaching to caudal base; fragile, setiform, about equal to body depth, about 3 times dorsal base; not prolonged, however, in specimens less than 100 mm long. Anal long, equals head without snout, about 2 in body depth; last ray reaches to first third caudal; height 2.5 in base. Pectorals high, about equal head; first ray strong, stout; reaches to about insertion of ventrals. Ventrals 1.6 in pectorals, slightly less than twice orbit, equidistant from pectorals and anal measured from origin to origin. Caudal 2.7 in body length. With a characteristic black spot on shoulder.

The above description is based on No. 4311, 154 mm, Zamboanga, June 3, 1908; No. 5347, 151 mm, and No. 5348, 145 mm, Panacan, Palawan, August 16, 1908.

This species is easily confused with Clupanodon punctatus, in having the last dorsal ray produced, and in having similar head and fins. Besides differing in the structure of the maxillary, the two species differ by the following characters: Depth of Nematalosa nasus about 2 or slightly more than 2; C. punctatus, 3 or more. Scales in longitudinal series, about 40 in N. nasus, about 50 in C. punctatus; transverse scales, 18-19 in N. nasus, 20-23 in C. punctatus. Scales similar in that both have the characteristic single uninterrupted transverse striæ; but the scales of N. nasus have the posterior edge serrate, in C. punctatus the edge is smooth, rarely serrate.

The above differentiation of the two species is made possible by the presence of two specimens of *C. punctatus*, Nos. 10388 and 23053, from Amoy, China.

LUZON, Pampanga Province, Macabebe, Pilipit, Nos. 15326, 23043, 86–88 mm, May 7, 1927: Zambales Province, Iba, No. 11957, 80 mm, October 26, 1921: Manila market, No. 410, 162 mm, June 27, 1907; Manila Bay, No. 41250, 150 mm, October 20, 1929: Rizal Province, Malabon, No. 713, 170 mm, July 18, 1907; Nos. 15300, 110 mm, April 30, 1927; No. 15305, 110 mm, March 31, 1927: Sorsogon Province, Bacon, No. 23052, 167 mm, 1904: Albay Province, Legaspi market, No. 11820, 180 mm, September 21, 1924. Panay, Antique Province, San Jose, No. 13145, 57 mm, 1926; No. 23053, 50 mm, 1927: Iloilo Province, Dumangas, Nos. 15451, 23562, 71–60 mm, August 5, 1927; La Paz, No. 15455, 73 mm, August 6, 1927; Molo, No. 15468, 96 mm, August 5, 1927.

PALAWAN, Palawan Province, Panacan, Paragna, Nos. 5348, 150 mm, August 16, 1908; Barrio Guinlo, Malampaya Sound, Nos. 15640, 23048-49, 112-117 mm, April 26, 1927. MINDANAO, Zamboanga Province, Zamboanga, No. 4311, 150 mm, June 3, 1908.

## Genus ANODONTOSTOMA Bleeker

Supplemental maxillary very slender; scales 40 to 42 in median lateral series, 12 to 17 in transverse series; dorsal rays 17 to 19 with broad basal scaly sheath extending to end of last ray; anal rays 18 to 21 and depressible in scaly sheath; ventral with 8 rays, below middle or front half of dorsal.

ANODONTOSTOMA CHACUNDA (Hamilton-Buchanan). Cabase. Plate 1, fig. 13; Plate 3, fig. 1.

Clupanodon chacunda HAMILTON-BUCHANAN, Fishes Ganges (1822) 246.

Gonostoma javanicum VAN HASSELT, Algemeene Konst en Letterbode (1823) 329.

Chatoessus chacunda Cuvier and Valenciennes, Hist. Nat. Poiss. 21 (1848) 81; Cantor, Journ. Asiat. Soc. Bengal 18 (1850) 1293; Bleeker, Verh. Bat. Gen. 24 (1852) 46; Kner, Fische Novara Exp. (1865-1867) 337; Günther, Cat. Brit. Mus. 7 (1868) 411; Day, Fishes of India 4°. (1878-1888) 632.

Anodontostoma hasseltii BLEEKER, Verh. Bat. Gen. 22 (1849) 15; FOWLER, Mem. B. P. Bishop Mus. 10 (1928) 32.

Chatoessus selangkat BLEEKER, Verh. Bat. Gen. 24 (1852) 47.

Dorosoma chacunda BLEEKER, Atl. Ichth. 6 (1866-1872) 143; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 25.

Dorosoma indicus CHAUDHURI Mem. Indian Mus. 5 (1916) 419.

Anodontostoma chacunda Fowler, Hongkong Nat. 2 (1931) 79; HERRE, Fish. Herre 1931 Philip. Exp. (1934) 15.

Head 3.5-3.8; depth 2.0-2.2; dorsal 18-19; anal 18-19; scales 35-38 in longitudinal series; 13-14 in transverse series; 13-15 predorsals; abdominal scutes, 16-17 preventrals, 10-12 postventrals.

Body oblong, strongly compressed, deep. Profiles greatly convex; belly less trenchant anteriorly, with spiny scutes. Head small, width 1.8 to 1.9 in its length; snout heavy, shorter than eye which is 3.4 to 3.6 in head. Maxillary straight, thin, transversely expanded and tapering terminally; reaches to slightly past front margin of pupil. Interorbital about eye diameter, slightly convex, keeled at center, with thick adipose covering. Venations on cheeks. Gill rakers 74 to 78, fine, smooth, flattened, shorter than gill filaments. Pseudobranchiæ 16 to 18. Scales adherent, large, wider than long, with 4 to 7 transverse

striæ, 1 to 2 of which are usually continuous; posterior margin "ctenoid," with pseudospines; basal margin smooth.

Dorsal origin nearer to caudal base than to snout tip; last ray not produced, base longer than height, about head minus snout. Anal rather long, about 1.6 in head, 2.6 to 2.8 in body depth, equals length of operculum; last anal ray barely, if at all, reaching base of caudal, height 6.6 to 6.8 in base. Pectorals high, slightly less than head; first ray well developed, strong. Ventrals about preocular part of head, midway between pectorals and anal measured from origin to origin. Caudal 2.7 to 2.8 in body length. With a characteristic black spot, less than eye, on shoulder.

This species is easily differentiated from *N. nasus* by the absence of a prolonged setiform dorsal ray which is characteristic of the latter. This alone does not separate the two species of sizes below 100 mm as it is equally undeveloped in both. *A. chacunda*, however, has 13 to 14 scales in the transverse series, the scales are larger, with 6 to 8 transverse striæ, and there are less than 100 gill rakers.

The above description is based on No. 14795, 135 mm, No. 23050, 139 mm, and No. 23151, 133 mm, obtained from Basey, Samar, December 6, 1926.

LUZON, La Union Province, Rosario, Barrio Damortis, Nos. 14320, 23047, 99-94 mm, August 3, 1926; Barrio Rabon, No. 12453, 137 mm, August, 1926: Bataan Province, Orani, No. 11311, 114 mm, April 29, 1923: Rizal Province, Malabon, No. 714, 182 mm, June 18, 1907: Manila, Manila market, Nos. 13-15, 99-105 mm, May 21, 1907; No. 139, 113 mm, June 12, 1907; No. 312, 108 mm, June 17, 1907; No. 972, 100 mm, September, 1907: Camarines Sur Province, San Miguel Bay, Nos. 10433, 23043-46, 69-105 mm, January 3, 1919; Calabanga, Nos. 13243, 23033-36, 99-165 mm, January 16, 1926. MINDORO, Mindoro Province, Mangarin, Nos. 11032, 23041, 118-91 mm, 1913. MASBATE, Masbate Province, Guinobatan, No. 1061, 97 mm, August 30, 1902. LEYTE, Leyte Province, Tacloban, No. 1190, 124 mm, September 24, 1907; No. 9579, 134 mm, May 7, 1921; Carigara, No. 7888, 123 mm, December 11, 1913. SAMAR, Samar Province, Basey, Nos. 14795, 23050-51, 51-127 mm, December 2, 1926. PANAY, Iloilo Province, Estancia, Nos. 11654, 23031, 95-97 mm, February 11, 1925; Molo, No. 15468, 85 mm, August 5, 1927: Capiz Province, Capiz, Nos. 12749, 23032, 110 mm, July 30, 1925: Antique Province, Culasi, No. 41123, 89 mm, December 15, 1933. Guimaras, Iloilo Province, La Paz, No. 15455, 75 mm, August 6, 1927; Dumangas, Nos. 15451, 23562, 65 mm, August 5, 1927; West coast of Guimaras, No. 41321, 72 mm, December 18, 1934. Balabac, Palawan Province, Balabac, Nos. 5059–5064, 172–174, August 5, 1908. Mindanao, Davao Province, Davao, 3232, 3486, 125–184 mm, April 25, 1908: Agusan Province, Agusan River, No. 4236, 154 mm, 1904.

In the collection are the following extra-Philippine specimens: BORNEO, Sandakan, Nos. 2450, 2511, 2541, 2562-65, 2617, 2675, 71-104 mm, February, 1908; No. 14160, 106 mm, November 21, 1925.

## **ENGRAULIDÆ**

Body oblong, elongate, more or less compressed, scales thin, deciduous; belly cultrate or slightly rounded with keeled abdominal scutes; snout prominent, mouth large, bordered by very small intermaxillaries which do not meet in symphysis, and by the long narrow maxillaries which may be prolonged. Teeth in jaws in one row, small, rarely caninoid; teeth present on vomer, palatines, pterygoid and tongue. Dorsal somewhat short, above or in front of anal; anal usually long. Gill membranes more or less united, free from isthmus; 7 to 19 branchiostegals, gill rakers long, slender; pseudobranchiæ present.

This family is usually divided into two subfamilies; namely, the Coilinæ, in which the body is greatly elongate and the long anal fin unites with the caudal; and the Stolephorinæ, in which the body is not greatly elongate and the anal fin is shorter and not united with the greatly forked caudal. All Philippine members of the family belong to the latter. We have for comparison, however, a number of examples of the genus *Coilia* obtained from China.

Key to the Philippine genera of the Engraulidæ.

- a. Maxillary greatly prolonged, extending to base of pectoral or beyond.

  Thrissocles.
- a. Maxillary moderate, not extending to base of pectorals.

#### Genus THRISSOCLES Jordan and Evermann

Body shape and compression similar to *Scutengraulis*; maxillary excessively long, extending beyond base of pectorals, sometimes even up to anal; gill rakers 10 to 18; pectorals reach to ventrals; origin of anal below last rays of dorsal; no silvery lateral stripe.

One Philippine species.

#### THRISSOCLES SETIROSTRIS (Broussonet). Plate 1, fig. 6.

Clupea setirostris Broussonet, Ichth. 1 (1782).

Clupea mystacina Forster, Schneider Syst. Ichth., Bloch (1801) 482; LICHTENSTEIN, Forster Descript. anim. (1844) 295.

Engraulis setirostris Cuvier and Valenciennes, Hist. Nat. Poiss. 21 (1849) 69; GÜNTHER, Cat. Brit. Mus. 7 (1868) 397; BLEEKER, Atl. Ichth. 6 (1866-72) 134; DAY, Fishes of India 4°. (1878-1888) 626.

Thryssa macrognathus BLEEKER, Bijd. Ichth. Madura, Verh. Bat. Gen. 12 (1849) 14.

Stolephorus setirostris Günther, Cat. Brit. Mus. 7 (1868) 397.

Anchovia setirostris Jordan and Richardson, Bull. U. S. Bur. Fish. 27 (1907) 237.

Engraulis setirostris Günther, Fische der Südsee 3 (1909-1910) 379; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 258; Mem. B. P. Bishop Mus. 10 (1928) 32.

Thrissocles setirostris Fowler, Hongkong Nat. 2 (1931) 202; HERRE, Fish. Herre 1931 Philip. Exp. (1934) 15.

Head 3.7-3.9; depth 3.2-3.5; dorsal I, 10-13; anal 34-36; scales 39-42 in median lateral series; 10-11 in transverse series; 20-22 predorsals; abdominal scutes 27-28, 18 being postventral.

Body elongate, strongly compressed, dorsal and ventral profiles about equal, belly cultrate. Head blunt, snout prominent, short, much less than eye which is 3.5 to 3.7 in head. Maxillary produced to a long filament surpassing ventrals, often reaching anal, strongly expanded near mandibular joint. Jaws with a single row of minute teeth; maxillary prolonged, extending beyond ventrals, often to anal, toothed throughout its entire inferior margin. Dorsal surface of head laterally convex with a prominent median keel; interorbital slightly less than eye. Venules conspicuously wanting. Gill rakers 12, finely lanceolate, flattened, inner side spinulose, slightly longer than gill filaments, nearly equal eye. Scales deciduous, with 9 to 12 vertical striæ, some discontinuous with median terminals overreaching each other; margins smooth, nonfenestrate.

Dorsal origin slightly nearer caudal base than snout tip; base short, 2 in its height which is slightly longer than head without

snout. Anal long, 3 to 3.3, about twice height. Pectorals about height of dorsal, reaching past ventral insertion. Ventrals more than twice eye, midway between pectorals and anal; reaches to anal opening.

Black venules on shoulder; pale reddish spots superior and inferior to ventral and pectoral bases.

The above description is based on No. 977, 69 mm, obtained in a Manila market, July, 1907.

LUZON, Cagayan Province, Aparri, No. 10384, 117 mm, May 22, 1923: Rizal Province, Malabon, No. 10423, 117 mm, April 21, 1923: Manila, Nos. 63, 207, 208, 977, 110-111 mm, June 12, 1907. MINDORO, Mindoro Province, Calapan, No. 10357, 98 mm, January, 1923; Mangarin, Nos. 11552, 23875-78, 90 mm, 1913.

In the collection are the two following foreign specimens: No. 10345, 115 mm, from Amoy, China, 1923, and No. 10105, 70 mm, from Hoihao, Hainan, 1923, both collected by S. F. Light.

In addition, the following specimens of *Thrissocles dussumieri* (Bleeker) are in the collection: No. 6398, 82 mm, from Hongkong, August, 1910; Nos. 6248, 6253, 6261-62, all about 98 mm long, from Hongkong, 1910. In this species the maxillary does not extend beyond the ventrals.

## Genus SCUTENGRAULIS Jordan and Seale

Body thin, deep, compressed, elongate. Scales more or less deciduous. Strong abdominal scutes always present between pectorals and anal, also in front of pectorals. Mouth oblique; maxillary usually produced, ending between mandibular joint and axil of pectoral, usually extending beyond gill-opening. Origin of dorsal ahead of that of anal which is usually rather long (27 to 50 rays). A tiny free spine in front of dorsal. Upper pectoral rays not produced. Teeth present on jaws, vomers palatines, pterygoid, and tongue. No caninoid teeth.

This genus is represented by two species in the Philippines. In addition several specimens of *Scutengraulis hammalensis*, Nos. 10369, 23890-96, all about 88 mm long, from Amoy, China, are in the collection.

## Key to the Philippine species of Scutengraulis.

- a1. Maxillary reaches only to gill opening........... S. hamiltonii (Gray).
- a 2. Maxillary nearly reaches root of pectoral............. S. mystax (Bloch).

SCUTENGRAULIS HAMILTONII (Gray). Dumpilas. Plate 1, fig. 10.

Thryssa hamiltonii Gray, Illustr. Indian Zool. 2 (1830-35) Pisc. tab. 5, fig. 3 (fig. only).

Engraulis grayi BLEEKER, Verh. Bat. Gen. 24 (1852) 41; KNER, Fische Novara Exp. (1865-67) 333.

Engraulis hamiltonii GÜNTHER, Cat. Brit. Mus. 7 (1868) 395; DAY, Fishes of India 4°. (1878-1888) 625; VINCIGUERRA, Ann. Mus. Civ. Genova 2 (1885) 94; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 258.

Stolephorus hamiltonii Bleeker, Ned. Tijdschr. Dierk. 1 (1863) 261. Engraulis poorawah Bleeker, Atl. Ichth. 6 (1866-72) 132.

Trichosoma hamiltonii RUTTER, Proc. Acad. Nat. Sci. Phila. (1897) 66.

Anchovia hamiltonii Jordan and RICHARDSON, Bull. Bur. Fish. 27 (1907) 236.

Engraulis grayi Weber and de Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 37.

Scutengraulis hamiltonii JORDAN and SEALE, Bull. Mus. Comp. Zool. Harvard 67 (1926) 371.

Anchoviella hamiltonii Deraniyagala, Ceylon Journ. Sci. § C 5 (1933) 81.

Head 4.4; depth 3-3.4; dorsal I, 14; anal 40; scales 38-39 in median lateral series; 11-12 in transverse series, 15 predorsals; abdominal scutes, 16 preventrals, 10 postventrals, sharp and spiny, especially the postventrals.

Body oblong, deep, well compressed; ventral profile slightly more convex than dorsal. Snout shorter than eye, which is 4.3 in head. Maxillary produced, reaching gill opening; dilated at mandibular joint, from thence tapering posteriorly to a sharp point. Jaws about equal with a single row of minute sharp teeth. Dorsal part of head with a sharp median keel, convex, finely tuberculate; interorbital equal eye. Gill rakers 14, strongly flattened, with prominent spines on inner edge; about 1.4 longer than filaments, slightly less than orbit. Scales large, rather deciduous, with 7 to 15 transverse striæ, broken, irregularly arranged, those near posterior border anastomosing and reticulose; posterior margin irregularly serrate.

Dorsal origin nearer caudal than snout tip; base short, about 2 in its height which is about equal to head without snout. Anal long, 3.1 in body length, height 2.7 in its base. Pectoral nearly as long as height of dorsal, reaches to ventral origin, first ray large, strong. Ventral small, about 1.5 times eye, 2.7 in pectoral, nearer pectoral than anal, far in advance of dorsal origin.

With black venules on scapular region.

This description is based on No. 41286, 197 mm, collected by Mr. A. F. Umali from Divisoria market, March 13, 1931.

Luzon, Camarines Sur Province, Calanga, Nos. 13244, 23853-23863, 120-125 mm, January 16, 1926. Leyte, Leyte Province, Tacloban, No. 1200, 170 mm, September 4, 1907.

In addition, we have 5 specimens, No. 10126, 113 mm, from Haichow, Hainan, China.

## SCUTENGRAULIS MYSTAX (Bloch). Plate 1, fig. 8.

Clupea mystax Bloch, Schneider Syst. Ichth. (1801) 426.

Thryssa porava Bleeker, Verh. Bat. Gen. 22 (1849) 14.

Engraulis mystacoides Bleeker, Verh. Bat. Gen. 24 (1852) 42; GÜNTHER, Cat. Brit. Mus. 7 (1868) 396.

Engraulis hamiltonii KNER, Fische Novara Exp. (1865-67) 334.

Engraulis mystax BLEEKER, Atl. Ichth. 6 (1868-72) 132; DAY, Fishes of India 4°. (1878-1888) 625; Weber and De Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 38; CHAUDHURI, Mem. Indian Mus. 5 (1916) 424.

Trichosoma porava RUTTER, Proc. Acad. Nat. Sci. Phila. (1897) 65. Scutengraulis mystax Jordan and Seale, Bull. Mus. Comp. Zool. 67 (1926) 370.

Head 4.3-4.7; depth 3.3-3.5; dorsal I, 14; anal 40-42; scales 40-44 in median lateral series; 11-12 in transverse series; preventral scutes 17-19 (5 or 6 of which are prepectorals); postventrals 9-11.

Body oblong, well compressed, dorsal profile nearly straight; ventral profile well convexed. Mouth large; maxillary much elongate, tapering to a point, and nearly reaching base of pectorals. Snout short, slightly longer than half diameter of eye which is 4 in head; a single row of small teeth on each jaw. Teeth on pterygoid, vomer, palatine, and tongue. Upper surface of head with a median longitudinal crest which extends from snout to nape; tuberculate and with small melanophores along sides of crest. Interorbital equal to eye. Branchiostegals 11 to 13; gill rakers 13, compressed, rather firm, distinctly spinous. Scales large, adherent, with 4 to 8 transverse striæ, 2 to 4 continuous; hind margin serrated with narrow and regular crenulations.

Dorsal slightly nearer caudal than snout; base 1.6 in height which is more than twice body depth. Anal long, 2.7 to 3, inserted below posterior ray of dorsal; height twice caudal peduncle. Pectorals slightly longer than head without snout. Ventrals small, 2.5 in pectorals, greater than orbit; inserted

well in front of dorsal; much nearer pectorals than anal; pectorals extending past ventral origin.

Scapular region with melanophores in clusters arranged in rows; dark spots along dorsal margin from head to caudal.

The above description is based on Nos. 23951 and 23954, 100 mm and 112 mm, obtained from Cabusao, Camarines Sur.

Luzon, Camarines Sur Province, Cabusao, Nos. 11454, 23951–54, 78–100 mm, December 21, 1918; San Miguel Bay, Nos. 115687, 23976–82, 71–113 mm, September 27, 1924; No. 12039, 119 mm, February–March, 1922. Samar, Samar Province, Basey, No. 14721, 152 mm, December 6, 1926. Panay, Iloilo Province, Barotoc, No. 15448, 90 mm, August 4, 1927. Negros, Negros Occidental Province, Cadiz, No. 16190, 132 mm, August, 1929.

One specimen, No. 14175, 78 mm, was collected from Sandakan, Borneo, November 21, 1925.

## Genus THRISSINA Jordan and Seale

Scutes small, almost hidden by the scales, usually absent in front of pectorals. Body moderately compressed not very deep. Maxillary not extending posterior of root of mandible. Gill rakers about 23.

## THRISSINA BÆLAMA (Forskål). Dumpilas. Plate 1, fig. 7.

Clupea baelama Forskål, Descript. anim. (1775) 72; Bloch, Schneider, Syst. Ichth. (1801) 429.

Engraulis bælama Cuvier and Valenciennes, Hist. Nat. Poiss. 21 (1848) 26; Günther, Cat. Brit. Mus. 7 (1868) 393; Bleeker, Atl. Ichth. 6 (1866-72) 130; Klunzinger, Verh. z. b. Ges. Wien 21 (1871) 597; Günther, Proc. Zool. Soc. London (1871) 671; Day, Fishes of India 4°. (1878-1888) 626; Günther, Fische der Sudsee 3 (1909-1910) 379.

Stolephorus encrasicholoides Bleeker, Ned. Tijdschr. Dierk. 1 (1863) 236.

Engraulis encrasicholoides KNER, Fische Novara Exp. (1865-1867) 333; GÜNTHER, Cat. Brit. Mus. 7 (1868) 387; SCHMELTZ, Cat. Mus. Godeffroy (1869) 25; MACLEAY, Proc. Linn. Soc. N. S. W. 7 (1882) 593; 8 (1883) 278.

Anchovia baelama Jordan and Richardson, Bull. Bur. Fish. 27 (1907) 236; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 239.

Engraulis bælama Weber and de Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 33; Fowler, Proc. Acad. Nat. Sci. Phila. 79 (1927) 258; Mem. B. P. Bishop. Mus. 10 (1928) 32.

Thrissina baelama JORDAN and SEALE, Bull. Mus. Comp. Zool. 67 (1926) 376; HERRE, Fish. Herre 1931 Philip. Exp. (1934) 15.

Head 3.5-3.7; depth 4-4.4; dorsal II, 13; anal 27-30; scales 34-36 in lateral median series; 9 in transverse series; 14 predorsals; 17 abdominal scutes, 8 preventrals.

Body only compressed, not very deep, dorsal and ventral profiles nearly equal in convexity, scutes pointed behind, weakly attached, none in front of pectorals except a single reduced one, just behind isthmus. Length of caudal peduncle about equal to its least depth, less than 3 in head. Snout large, length less than an orbit, about 4.5 in head. Mouth large, oblique; maxillary long but not extending beyond root of mandible; equals head minus snout, longer than ventrals, thick and narrow anteriorly, rather broad and flat posteriorly. Lower jaw short, small, extensible below ventral margin. Both jaws with a row of firm, minute, closely-set teeth. Teeth on vomer, tongue, pterygoid, and palatine. Eye well advanced, 3 times nearer snout than opercular opening. Interorbital convex, keeled on median longitudinal plane, striated and tuberculate. Posterior opercular edge oblique, dorsal portion well advanced. Cheeks veined, tub-Branchiostegal rays 13 to 15. Gill rakers 19 to 23, lanceolate, compressed, spinulous on exposed edge, longer than filaments, slightly less than orbit. Pseudobranchiæ 20 to 22, short, unequal, base hidden in membranous flap. Scales rather adherent, large with 12 to 15 transverse strictions. margin irregularly serrate, produced portion often with several small reticula.

Dorsal nearer snout than caudal base, well in front of anal; base about 1.8 in its longest ray. Ventrals 2.2 in head, longer than caudal base, slightly nearer pectorals than anal. Pectorals longer than ventrals, just reaching insertion of latter. Anal long, about equal body depth, twice length of peduncle; height slightly less than ventrals.

This description is based on Nos. 23931 and 23943, 90 and 95 mm.

Luzon, Cagayan Province, Buguey, Barrio Mission, No. 12884, 68 mm, December 9, 1905: Ilocos Norte Province, Bangui, Barrio Caunayan, Nos. 14366, 23920-23, 81-91 mm, August 19, 1926: La Union Province, Luna, No. 14305, 55 mm, August 10, 1926: Manila, Manila market, Nos. 524, 977, 83-69 mm, July, 1907; Nos. 6798, 6805, 62-65 mm, June, 1910: Rizal Province, Pasay, No. 12464, 70 mm, October 17, 1905: Batangas Province, Batangas, No. 2225, 67 mm, June 16, 1908: Albay Province, Legaspi, Legaspi market, Nos. 13330, 23930-50, 81-100 mm, February 2, 1926. Leyte Province, Cabalian, Nos. 10829,

23792-95, 79-91 mm, May 24, 1922. Panay, Iloilo Province, Estancia, Nos. 23914-17, 86 mm, July, 1922. Negros, Oriental Negros Province, Polo Plantation, No. 15444, 92 mm, August 21, 1927. Bantayan, Cebu Province, Bantayan, Nos. 5961, 5966, 5969, 54-70 mm, May, 1909. Mindanao, Misamis Province, Cagayan, No. 1452, 78 mm, September 8, 1907; No. 1557, 84 mm, September 12, 1907: Surigao Province, Surigao, No. 10902, 92 mm, June 5, 1922: Zamboanga Province, Zamboanga, Nos. 2897, 2899, 21472, 23809-10, 58-88 mm, April 10, 1908; No. 2978, 53 mm, April 13, 1908; No. 4195, 49 mm, May 28, 1908; Nos. 23802-03, 51-69 mm, June, 1908: Davao Province, Davao, Nos. 3325, 3329, 23800-01, 23806-08, 42-88 mm, April 24, 1908; No. 3468, 94 mm, April 26, 1908; No. 4540, 65 mm, April 21, 1908. Samal, Davao Province, Samal, Nos. 3574, 23804-05, 32-73 mm, April 29, 1908.

## Genus STOLEPHORUS Lacépède

Body elongate. Scales thin, deciduous; not more than 7 prominent spiny scutes between pectorals and ventrals. Snout prominent; maxillary may be produced up to gill opening. Dorsal without small predorsal spine, placed totally or partly in front of anal. Anal short with 16 to 23 rays. Upper pectoral ray not produced. Teeth present on jaws, vomer, palatines, pterygoids, and tongue. Branchiostegals 11 to 13; caudal peduncle at least twice as long as high at its end. A silvery band present along the sides.

This genus is represented by four species in the Philippines, one of which is not present in the collection.

Key to the Philippine species of Stolephorus.

a. Origin of anal behind dorsal; anal about 6 in length.

S. heterolobus Rüppell.

- a2. Origin of anal below dorsal.

  - b2. Four to five abdominal scutes between pectorals and ventrals.

    - $c^2$ . Maxillary reaching gill opening; anal 5 to 5.4 in length.

S. tri (Bleeker).

### STOLEPHORUS COMMERSONII Lacépède. Dilis; bolinao. Plate 2, fig. 6.

Stolephorus commersonii LACÉPÈDE, Hist. Nat. Poiss. 5 (1803) 382; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 45; CHAUDHURI, Mem. Indian Mus. 5 (1916) 426. Engraulis Brownii Cuvier and Valenciennes, Hist. Nat. Poiss. 21 (1848) 29 (ex parte); Kner, Fische Novarra Exp. (1865–1867) 332. Engraulis commersonianus Günther, Cat. Brit. Mus. 7 (1868); Day, Fishes of India 4°. (1878–1888) 629.

Stolephorus commersonianus Bleeker, Atl. Ichth. 6 (1866-72) 128. Anchovia commersoniana Jordan and Seale, Bull. U. S. Bur. Fish. 26 (1906) 5.

Anchovia commersonii Fowler, Copeia No. 58 (June, 1918) 62. Engraulis commersonii Fowler, Proc. Acad. Nat. Sci. Phila. 79 (1927) 258.

Head 3.7-4; depth 4.8-5.2; dorsal 14-15; anal 19-20; scales 37-40 in median lateral series, 8 in transverse series; 15-18 predorsals; 5-7 abdominal scutes, with sharp spines, between ventrals and pectorals.

Body elongate, slightly compressed; dorsal and ventral profiles equally convex. Mouth large, maxillary extending almost to gill opening, broad behind and with large teeth inserted at wide intervals among minute teeth. Snout less than eye diameter which is 3.6 in head. Tubercles on cheek, postorbital, preopercle, and top of head. Interorbital about an eye. Gill rakers 20 to 21, spiny on inner edge, slightly flattened, rather slender, about twice gill filaments, slightly less than eye. Scales very deciduous, large, with a variable number of transverse and longitudinal striæ which are often anastomosing and reticulate; margins smooth.

Dorsal slightly nearer snout tip than caudal base; base less than height, about 2 in head. Anal short, 5.4 to 5.8, inserted below last rays of dorsal. Pectorals less than maxillary, about 1.7 in head. Ventrals longer than orbit, slightly nearer pectorals than anal, ahead of dorsal origin.

With a prominent silvery lateral band which attains greatest width posteriorly. Top of head, nape, upper portion of oper-culum, lateral band, base of dorsal, and whole caudal fin powdered with minute melanophores.

Described from Nos. 7896, 41182, 41183, and 41184, ranging in size from 37 to 70 mm, collected from Carigara, Leyte Province, March 10, 1913.

LUZON, Manila, Manila market, Nos. 6855-57, 57-58 mm, July, 1915. SAMAR, Samar Province, Catbalogan, No. 12500, 54-62 mm, September 19, 1925. LEYTE, Leyte Province, Carigara, Nos. 7896, 41182-41184 (212 specimens), 37-70 mm, March 10, 1913.

STOLEPHORUS INDICUS (van Hasselt). Tuakang or dilis. Plate 2, fig. 8.

Engraulis indicus VAN HASSELT, Algemeene Konst en Letterbode (1823) 329; DAY, Fishes of India 4°. (1878–1888) 629; STEINDACHNER, Sitz. Akad. Wiss. Wien 115 (1906) 1424; GÜNTHER, Fische der Südsee 3 (1909–1910) 377; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 259.

Engraulis albus SWAINSON, Fishes 2 (1839) 293.

Engraulis balinensis BLEEKER, Verh. Bat. Gen. 22 (1849) 11.

Engraulis brownii Cantor, Journ. Asiat. Soc. Bengal 18 (1849) 1285 (nec Gaimard); DAY, Fish. Malabar (1865) 237; PLAYFAIR and GÜNTHER, Fish. Zanz. (1866) 123.

Engraulis russelli BLEEKER, Verh. Bat. Gen. 24 (1852) 38; GÜNTHER, Cat. Brit. Mus. 7 (1868) 790.

Engraulis samaninan Thiolliere, Fauna Woodlark (1857) 208.

Stolephorus indicus BLEEKER, Atl. Ichth. 6 (1866-1872) 127; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 46; CHAUDHURI, Mem. Indian Mus. 5 (1916) 425.

Anchovia indica Jordan and Herre, Proc. U. S. Nat. Mus. 31 (1906) 638; Jordan and Seale, Bull. U. S. Fish. 26 (1906) 5; EVERMANN and Seale, Bull. U. S. Fish. 26 (1906) 54.

Engraulis indica FOWLER, Mem. B. P. Bishop Mus. 10 (1928) 33.

Head 3.8-4.2; depth 5.2-5.5; dorsal 16; anal 19-20; scales 37-40 in median lateral series; 8-9 in transverse series; 19-20 predorsals; 4 spiny abdominal scutes between ventrals and pectorals.

Body elongate, slightly compressed; profiles more or less equally convex, with a prominent silvery band along sides, greatest width about snout length. Caudal peduncle long, about head without operculum, 4.5. Snout prominent, slightly more than 2 in eye; maxillary flat, broad, reaching to front border of preopercle. Top of head laterally convex, flat dorsally, crested at median line; interorbital 1.3 in eye which is 3.3 to 3.5 in head. Gill rakers 20 to 22, flattened, spinous on inner edge, with characteristic furrow along center of flat surfaces. Branchiostegals 11. Scales very deciduous, large, with 4 to 9 crenulations arising from basal margin extending to about middle portion and ending posteriorly as groove of regular and distinct serrations of the margin. Basal margin lined by 2 to 4 layers of thick-walled reticula, the marginal ones being produced anteriorly to a point giving margin a comblike aspect.

Dorsal nearer snout than caudal; base greater than height, about twice orbit. Anal short, 6 to 6.2, well advanced, less than caudal peduncle, inserted about last third of dorsal base. Ven-

trals slightly longer than an orbit, inserted about midway from pectorals and anal. Pectoral slightly more than 2 in head; not reaching ventrals. With a characteristic black heart-shaped spot on postfrontal and a brown one on nape.

The above description is based on Nos. 12358, 23915, 23916, and 23929, 87 to 93 mm, collected from San Pedro Bay, near Basey, Samar, September 17, 1925.

LUZON, La Union Province, Damortis, Rosario, Nos. 14289, 23821-23, 64-89 mm, August 4, 1926: Rizal Province, Malabon, No. 753, 107 mm, July 18, 1907; Pasay, Nos. 12464, 23924, 72-73 mm, October 17, 1925: Manila, Manila market, No. 819, 82 mm, June 17, 1907; No. 928, 97 mm, May, 1907; No. 10964, 78 mm, 1922; Nos. 23971-75, 78-80 mm, 1912; Divisoria Market, Nos. 41248-49, 21248-9, 95-100 mm, March 13, 1931: Batangas Province, Balayan, Nos. 41221, 41243, 64-78 mm, December, MINDORO, Mindoro Province, Calapan, No. 10344, 99 mm, January, 1923; Nos. 23797-99, 96-100 mm, January, 1921. LEYTE, Leyte Province, Carigara, Nos. 14789, 23814, 98–104 mm, December, 1926; Nos. 7937, 7942, 97-99 mm, December 11, SAMAR, Samar Province, San Pedro Bay, near Basey, Nos. 23926-29, 86-91 mm, September 17, 1925. Negros, Negros Oriental Province, Zamboanguita, Nos. 13905, 23918-19, 86-104 mm, February 22, 1926: Occidental Negros Province, Licab, Nos. 21244-47, 107-108 mm, August 29, 1929; Sicaba, Nos. 41244, 41247, 110 mm, August, 1929. GUIMARAS, Iloilo Province, West coast of Guimaras Island, No. 41314, 35-68 mm, (22 young specimens), December 18, 1933.

#### STOLEPHORUS TRI (Bleeker). Plate 2, fig. 14.

Engraulis tri BLEEKER, Verh. Bat. Gen. 24 (1852) 40; GÜNTHER, Cat. Brit. Mus. 7 (1868) 389; von MARTENS, Exp. Ostasien, Zool. 1 (1876) 404; DAY, Fishes of India 4°. (1878-1888) 630; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 259.

Stolephorus tri BLEEKER, Atl. Ichth. 6 (1866-72) 128; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 47; CHAUDHURI, Mem. Indian Mus. 5 (1916) 426.

Head 3.7-4; depth 4.5-4.7; dorsal 14; anal 20-22; scales 30-32 in median lateral series along silvery band; 8-9 in transverse series; 19-23 predorsals; 4-6 spiny scutes between pectorals and ventrals.

Body elongate, more compressed than S. indicus, but with greater depth; ventral and dorsal profiles subequal. Caudal peduncle long, about 1.7 in head. Mouth large; maxillary flat, broad behind mandibular joint and extending as a blunt point

to edge of operculum. Snout less than eye which is 3 in head. Interorbital about an eye; top of head with sharp median keel. Gill rakers 22, spiny on inner edge, twice length of branchial filaments. Branchiostegals 13. Scales very deciduous, large, with 10 to 15 transverse continuous striæ; margin nonserrated.

Dorsal nearer caudal base than snout tip; base about its height and caudal peduncle. Anal advanced, 5 to 5.4, about equal to head without snout, height equals snout plus eye. Pectoral shorter than maxillary not reaching ventral which is slightly longer than eye diameter. Anal inserted midway between pectoral and anal.

With a characteristic dark brown spot on top of head behind interorbital divided into two halves by the median keel.

The above description is based on No. 23811, 72 mm, from Borongan, Samar, September 3, 1907, and No. 23925, 64 mm, from Carigara, Leyte, December 1, 1926.

Luzon, Manila, Manila market, Nos. 319, 416, 82 mm, June 27, 1907; No. 535, 75 mm, July 10, 1907: Bataan Province, Orani, Nos. 10949, 23958, 23970, 48–88 mm, April 23, 1923: South coast of Luzon, Nos. 375, 380, 382, 58–91 mm, June, 1907. SAMAR, Samar Province, Borongan, Nos. 1170, 23811–12, 62–74 mm, Dec. 3, 1907. GUIMARAS, Iloilo Province, West coast of Guimaras Is., No. 41147, 29–72 mm, (16 young specimens), December 18, 1933.

This species is close to *S. indicus* in having the same number of scutes, and the same characteristic mark on top of head, but it differs in that its maxillary extends to the margin of operculum. It is similar to *S. commersonii* in the extent of the maxillary but is easily distinguished from it in the number of scutes and in body proportions.

## CLUPEIDÆ

Body oblong, ventrally compressed with the belly keeled with scutes along edge. Snout never overshot; teeth either small or wanting. Mouth bordered by intermaxillaries but principally by maxillaries which have two supplemental bones. Pseudobranchiæ present and gill rakers slender. Scales thin, regular or pectinate, perforate or entire, and crenulate or smooth.

Key to the Philippine genera of Clupeidæ.

- a<sup>1</sup>. Anal fin moderate, with 15 to 25 soft rays; ventrals well developed, jaws equal.
  - b<sup>1</sup>. Origin of dorsal behind that of ventrals; vomerine teeth present.

    Clupeoides
  - b. Origin of dorsal before that of ventrals; no vomerine teeth.

- a 1. Anal fin with very long base; with more than 25 soft rays; ventrals small or wanting; dorsal fin present; lower jaw prominent.... Ilisha.

#### Genus CLUPEOIDES Bleeker

Body oblong, compressed, with ventral profile much more convex than dorsal. Scales thin but firm, ventral scutes prominent. Origin of ventrals ahead of or on same level as that of dorsal. Anal fin single. Teeth present on jaws, palatines, pterygoids, and vomer.

One Philippine species is known.

CLUPEOIDES LILE (Cuvier and Valenciennes). Silag. Plate 2, fig. 7.

Meletta lile Cuvier and Valenciennes, Hist. Nat. Poiss. 20 (1847) 378.

Alausa champil Cantor, Journ. Asiat. Soc. Bengal (1850) 1284 (nec Gray).

Rogenia argyrotaenia BLEEKER, Verh. Bat. Gen. 24 (1852) 26; BLEEK-ER, Nat. Tijdschr. Ned. Ind. 3 (1852) 457; KNER, Fische Novara Exp. (1865-67) 328.

Clupea argyrotaenia GÜNTHER, Cat. Brit. Mus. 7 (1868) 423.

Clupea (Clupeoides) argyrotaenia BLEEKER, Atl. Ichth. 6 (1872) 101. Clupea lile DAY, Fishes of India 4°. (1878-88) 638.

Harengula chrysotaenia Jordan and Seale, Bull. U. S. Bur. Fish. 25 (1906) 187.

Clupeoides lile Weber and De Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 57; Fowler, Mem. B. P. Bishop Mus. 10 (1928) 31; CHAUD-HURI, Mem. Indian Mus. 5 (1916) 426.

Head 4.2-4.5; depth 2.8-3.2; dorsal 16; anal 17; scales 36-38 in median lateral series; 9 in transverse series; 15-17 predorsals; 28 abdominal scutes, 17 being preventrals.

Body strongly compressed, abdomen extremely cultrate, sharp, bordered by prominent and firm scutes. Ventral profile greatly convex; dorsal profile slightly convex, keeled from nape to dorsal origin. Length of caudal peduncle slightly less than its least depth, 2.3 in head. Snout less than eye which is 2.6 to 2.8 in head. Gill rakers 37 to 40, finely lanceolate, smooth, about as long as filaments, about radius of eye. Pseudobranchiæ 12 to 15. Scales rather adherent, depth greater than length, with 1 to 3 continuous transverse striations; posterior margin weakly serrate.

Dorsal nearer snout than caudal, height about as long as base. Anal low, base about 1.7 times caudal peduncle, slightly

less than dorsal base and about 2 in body depth. Pectorals rather long, equal head measured from snout tip. Ventrals slightly more than 2 in head, about 1.6 in pectorals midway between snout tip and caudal peduncle and between pectorals and anal; anal opening depressed between last abdominal scute and anal fin.

Dorsal margin, post frontal, tip of snout, caudal fin, and base of caudal with dark spots.

The above description is based on three specimens.

LUZON, Camarines Sur Province, Barrio Sibubu, Nos. 13136, 2313, 54-67 mm, January 13, 1926. PANAY, Iloilo Province, Molo, No. 15467, 74 mm, August 5, 1927.

### Genus SARDINELLA Valenciennes

Body compressed; belly keeled, with scutes; no distinct median notch in upper jaw, teeth feeble on palatines and tongue; opercle without radiating striæ; pseudobranchiæ present; branchiostegals 6; scales large, firm, with interrupted striæ; anal long, last two rays enlarged; ventral opposite dorsal.

## Key to the Philippine species of Sardinella.

- a<sup>1</sup>. Belly obtuse, not sharp-edged; postventral scutes small and flatly carinated.
  - b¹. Maxillary reaches up to level of front edge of eye; 14 or 15 postventral abdominal scutes.
  - b . Maxillary distinctly distant from level of front edge of eye; 12 postventral abdominal scutes; no lateral band; 28 gill rakers.

S. clupeoides (Bleeker).

- a 2. Belly compressed, with sharp edge; medium scutes.
  - b. Scales in median lateral series less than 40.

S. jussieu (Lacépède).

- b 2. Scales in median lateral series 40 or more.
  - $c^{1}$ . Depth 3 to 4 in standard length.
    - d1. Scales in median lateral series about 40.

S. melanura (Cuvier and Valenciennes).

- d<sup>2</sup>. Scales in median lateral series more than 50.

  - e<sup>2</sup>. Scales pectinate, fenestrate.
    - $f^{1}$ . Depth 3.8 to 4 in length.

S. fimbriata (Cuvier and Valenciennes).

- d¹. Scales in transverse series 12 to 13; eye 4 to 4.5; depth about 4; teeth on palatines, pterygoid, and tongue; anal 13 to 16; gill rakers more than 140.
  - S. longiceps (Cuvier and Valenciennes).
- d<sup>2</sup>. Scales in transverse series 9 or 10; eye 3.5; depth 4.5 to 5; teeth on tongue only; anal 20; gill rakers 32.

S. schrammi (Bleeker).

Of the above, S. leiogaster, S. clupeoides, and S. schrammi are not represented in the collection.

#### SARDINELLA SIRM (Rüppell). Plate 2, fig. 4.

Clupea sirm RÜPPELL, Neue Wirbelthiere (1835–1840) 77; GÜNTHER, Cat. Brit. 7 (1868) 425; GÜNTHER, Fische der Südsee 3 (1909–1910) 383.

Sardinella leiogastroides BLEEKER, Nat. Tijdschr. Ned. Ind. 7 (1854) 255.

Clupea (Amblygaster) leiogastroides Bleeker, Atl. Ichth. 6 (1872) 102.

Sardinella sirm Jordan and Seale, Bull. U. S. Bur. Fish. 25 1905 (1906) 186; Fowler, Mem. B. P. Bishop Mus. 10 (1928).

Clupea (Amblygaster) sirm Weber and De Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 62.

Head 4-4.2; depth 4.6-4.8; dorsal 18; anal 18; scales 44-45 in median lateral series; 10-11 in transverse series; 13-14 predorsals; 16 preventral, and 15 postventral scutes.

Body moderately compressed; dorsal profile more convex than Least depth of caudal peduncle equal to its length. Head width 2 in its length. Snout width about 1.7 in its length which is 3.2 in head. Eye advanced, 3.5 to 3.7 in head. lary barely reaches front margin of eye, about 2.5 in head. Teeth on palatine, tongue, and pterygoid. Interorbital venulose, its width equal to orbit. Distinct striation on preopercle, suborbital, and postfrontal. Gill rakers 40 to 41, stout, lanceolate, fairly rigid, spinulated on compressed sides, smooth on edges; length more than a radius of orbit, 1.6 in branchial filaments; 20 pseudobranchiæ. Scales deciduous, large, entire; posterior margin uniformly serrated, indistinctly crenulate; 3 to 6 transverse striæ which are usually all interrupted at middle, scale close to that of S. longiceps but differs from this in having uniform weak serration on margin, in having usually no continuous transverse striæ, and in being relatively larger.

Dorsal origin nearer snout tip than caudal base; base longer than height, 2.2 to 2.4 in head. Caudal deeply forked, lobes shorter than head, covered with small alar scales. Pectorals 1.5 in head, longer than height of dorsal, first ray stout, hard. Ventral insertion below middle of dorsal, nearer pectoral than anal, 1.7 in pectoral, less than dorsal base. Anal base 2.5 times its height, about height of dorsal.

The above description is based on No. 13277, Legaspi, Albay Province, Luzon, February 2, 1926, and Nos. 21388-89, Sulade Island, Sulu Province, November 7, 1927, 173-191 mm.

Luzon, Batangas Province, Nasugbu, Barrio Papaya. No. 13265, 175 mm, January 13, 1926; Albay Province, Legaspi market, Nos. 21469-77, 13277, 15127, 58-173 mm, September 21, 1924. POLILLO, Tayabas Province, Polillo, No. 12597, 180 mm, September 25, 1925. MINDORO, Mindoro Province, Calapan, Nos. 11423, 21411-12, 129-130 mm, January 6, 1923; Bulalacao Bay, No. 14626, 160 mm, December 20, 1926; Pinamalayan, Nos. 6821, 21490. BANTAYAN, Cebu Province, Bantayan, Nos. 5957, 5970, 5989, 50-124 mm, May, 1909. Negros, Negros Oriental Province, Dumaguete, Nos. 15016, 21435, 171-172 mm, March 15, 1927. CAMIGUIN, Misamis Province, Catarman, Nos. 15020, 21440, 165-169 mm, February 10, 1927. MINDANAO, Misamis Province, Cagayan, No. 1451, 69 mm, September 8, 1907; Nos. 1745, 1759-60, 21310, 57-80 mm, September 15-17, 1907; No. 21308, 34 mm, September 13, 1908, Gingoog, Barrio Odiongan, No. 21423, 93 mm, February, 1927: Agusan Province, Butuan Bay, Nos. 1903, 1905, 84-97 mm, September 25, 1907: Davao Province, Davao, No. 3095, 80 mm, April 20, 1908; Nos. 3311, 3320, 92-118 mm, April 23, 1908; Nos. 3398, 3406, 60-67 mm, April 25, 1908: Zamboanga Province, Zamboanga, No. 4478, 65 mm, June 16, 1908; Nos. 21309-21313, 34-64 mm, 13, 1908. SAMAL. Davao Province, Samal, Nos. 3629-3631, 159-166 mm, May 1, 1908. Jolo, Sulu Province, Jolo, Nos. 2395, 2402, 2405, 2423, 24 to 150 mm, February, 1908. BUNGAU, Sulu Province, No. 13860, 178 mm, April 15, 1926. SULADE, Sulu Province, Nos. 15734, 21388-89, 21436, 171-191 mm, November 7, 1927.

SARDINELLA JUSSIEU (Lacépède). Plate 2, fig. 2.

Clupanodon jussieu Lacépède, Hist. Nat. Poiss. 5 (1803) 469-471. Clupea jussieui Günther, Cat. Brit. Mus. 7 (1868) 430.

Clupea otaitensis (Solander) Cuvier and Valenciennes, Hist. Nat. Poiss. 20 (1847) 257.

Spratella fimbriata Schmeltz, Cat. Mus. Godeffroy 4 (1869) 25. Clupea tembang Günther, Cat. Brit. Mus. 7 (1868) 426; Schmeltz, Cat. Mus. Godeffroy 5 (1874) 36; Günther, Report Voyage "Chal-

lenger" 1 (1880) 36.

Clupea gibbosa Günther, Fische der Sudsee 3 (1909-1910) 381. Harengula sundaica Kendall and Goldsborough, Mem. Mus. Comp. Zool. 26 (1911) 243. Clupea exile Kishinouye, Journ. Coll. of Agr. Tokyo 2 (1911) 384. Sardinella jussieu Fowler, Proc. Acad. Nat. Sci. Phila. 79 (1927) 257; Mem. B. P. Bishop Mus. 10 (1928) 30.

Head 4-4.2; depth 3.5-3.7; dorsal 16-17; anal 17; scales 37-39 in median lateral series; 10-11 in transverse series; predorsals 13-14; 16-17 preventral scutes, 12-13 postventrals.

Body spindle-shaped, compressed; belly cultrate with sharp rather prominent scutes; dorsal profile less convex than ventral. Caudal peduncle deep, least depth 1.2 times length which is 2.6 in head. Head very close to S. fimbriata; width 2.2 to 2.3 in its length. Snout width slightly narrower than its length which equals eye. Maxillary 2.3 in head, barely reaching below front margin of pupil. Interorbital equal to eye, slightly convex; postocular part of head with distinct striæ. Extensive venules on cheek, preopercle, and dorsal half of operculum. Gill rakers 45 to 49, lanceolate, broad, smooth, about as long as gill filaments. Scales large, adherent, nonfenestrate; posterior margin irregularly serrate, with 4 to 6 transverse striæ, one continuous.

Dorsal origin 1.3 times nearer snout tip than caudal base; base shorter than height, 1.7 in head, slightly more than 2 in body depth. Anal low, 1.3 in head, longer than dorsal base. Pectorals slightly shorter than anal, equal head minus snout. Ventrals 1.4 times longer than orbit, midway between pectorals and anal, below first quarter of dorsal.

This species is closest to *Harengula dispilonotus* in scale and gill raker count and to *Sardinella fimbriata* in the shape of the head. It differs, however, from the former in having the transverse striæ in the scales broken and in having a protruding snout. It differs from *S. fimbriata* in the scale and gill raker count and in the structure of the scales.

LUZON, Ilocos Sur Province, Santa Maria, Nos. 11200, 21494, 21495, 93-96 mm, January 23, 1923.

SARDINELLA MELANURA (Cuvier and Valenciennes). Plate 2, fig. 13.

Alausa melanura Cuvier and Valenciennes, Hist. Nat. Poiss. 20 (1847) 324.

Harengula (Paralosa) valenciennesi BLEEKER, Verh. Akad. Amsterdam (2) (1868) 300 (nomen solum).

Clupea melanura GÜNTHER, Cat. Brit. Mus. 7 (1868) 449; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 239.

Clupea (Harengula) melanurus Bleeker, Atl. Ichth. 6 (1872) 111. Clupea (Alausa) melanura von Martens, Exp. Ostasien, Zool. 1 (1876) 405.

Harengula melanura SAUVAGE, Poiss. Madagas. (1891) 492. Harengula vanicoris Jordan and SEALE, Bull. U. S. Bur. Fish. 25 (1906) 187. Clupea (Harengula) melanura Weber and de Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 72.

Sardinella melanura Fowler, Proc. Acad. Nat. Sci. Phila. 79 (1927) 257.

Head 3.8; depth 3.5-3.7; dorsal 15-17; anal 18-21; scales 38-40 in median lateral series; 10-11 in transverse series, 16-17 preventral scutes; 11 postventrals.

Body compressed, abdomen cultrate, with sharp, prominent scutes; ventral profile slightly more convex than dorsal; snout slightly concave. Caudal peduncle deep, greater than length which is 1.5 times eye diameter. Snout equals eye, about 3.3 in head; maxillary reaches to below front margin of pupil, slightly more than 2 in head. Striations on cheek, postorbital, and postfrontal. Interorbital about an eye, slightly convex, gill rakers 40 to 42, lanceolate, flattened, thickly-set, smooth. Scales moderate, rather adherent, entire, with 2 to 4 vertical striæ, 1 complete; hind border irregularly serrate; very similar to that of S. longiceps.

Dorsal origin nearer snout tip than caudal base, midway between snout tip and last ray of anal; length less than height which is 1.8 in head. Anal rather long, 1.6 in head. Pectorals equal head minus snout, greater than twice body depth. Ventrals 1.5 times eye, midway between pectorals and anal, below middle of dorsal.

BATAN, Batanes Province, No. 627, 70 mm, July, 1907. LEYTE, Leyte Province, Carigara, Nos. 7828-30, 37-47 mm, November 10, 1923.

SARDINELLA SAMARENSIS sp. nov. Tamban lirayan. Plate 2, fig. 11.

Head 3.8-4; depth 3.5-3.7; dorsal 18; anal 15; scales 43-45 in median lateral series; 9-11 in transverse series; 16-18 predorsals; 16-18 preventral scutes, 14-15 postventrals.

Body fusiform, compressed; dorsal profile slightly more convex than ventral; belly cultrate; scutes not very prominent. Snout width 1.4 in its length which is slightly greater than eye; tip produced to form with vertex a prominent concavity. Head width 2.4 in its length; eye 4, 1.8 nearer snout tip than hind margin of operculum. Maxillary 2.4 in head, reaches to below middle of eye. Interorbital rather concave, slightly less than orbit, equals greatest width of operculum. Postocular part of head deeply veined; venules on cheeks. Gill rakers 96 to 102, finely lanceolate, flattened, smooth, short, about half gill filaments which are 0.7 to 0.8 in eye. Scales adherent, subcircular,

nonfenestrate, with 2 to 5 transverse striæ, one usually complete; hind margin irregularly pectinate.

Dorsal 1.4 times nearer snout tip than caudal base; base depressed, equals height, about 2 in head. Anal low, 1.2 longer than dorsal, 1.7 in head, 1.6 times length of caudal peduncle. Pectorals equal anal base. Ventrals 1.5 times orbit, equidistant from pectorals and anal, inserted below middle of dorsal. Although in body shape this species is similar to *H. moluccensis* and *S. fimbriata*, its other characters are very distinct.

Samarensis, for Samar, the province and island from which the type was obtained.

Type.—No. 41217, 114 mm, collected by Mr. A. F. Umali from Barrio Cinco, Catbalogan, Samar Province, Samar Island, March 8, 1932. Two other specimens, Nos. 41218 and 41219, 104 mm, from the same place and of the same date, are also in the collection.

SARDINELLA FIMBRIATA (Cuvier and Valenciennes). Tunsoy or laolao. Plate 2, fig. 5.

Spratella fimbriata Cuvier and Valenciennes, Hist. Nat. Poiss. 20 (1847) 263; Bleeker, Verh. Bat. Gen. 24 (1852) 27; Kner, Fische Novara Exp. (1865-67) 329.

Clupea gibbosa Bleeker, Journ. Ind. Arch. 3 (1849) 72; GÜNTHER, Fische der Südsee 8 (1909) 381.

Spratella tembang BLEEKER, Verh. Bat. Gen. 24 (1852) 28; KNER, Fische Novara Exp. (1865-1867) 329.

Clupea tembang GÜNTHER, Cat. Brit. Mus. 7 (1868) 426.

Clupea fimbriata GÜNTHER, Cat. Brit. Mus. 7 (1868) 427; DAY, Fishes of India 4°. (1878–1888) 637.

Clupea (Harengula) fimbriata BLEEKER, Atl. Ichth. 6 (1872) 105; WEBER and DE BEAUFORT, Verh. Akad. Amsterdam 17 No. 3 (1912) 10; Fish. Indo-Austr. Arch. 2 (1913) 75.

Clupea (Harengula) sundaica Bleeker, Atl. Ichth. 6 (1872) 105.

Clupea (Harengula) gibbosa Bleeker, Atl. Ichth. 6 (1872) 106.

Clupea sundaica MACLEAY, Proc. Linn. Soc. N. S. W. 4 (1879) 373; JORDAN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 236.

Harengula gibbosa Jordan and Seale, Bull. Bur. Fish. 26 (1906) 4; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236.

Harengula sundaica JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236.

Sardinella fimbriata FOWLER, Copeia (June, 1918) 62; Proc. Acad. Nat. Sci. Phila. 79 (1927) 257.

Clupea (Harengus) fimbriata DERANIYAGALA, Spolia Zeylanica 15 (1929) 41.

Head 4.3; depth 3.5-3.6; dorsal 17-18; anal 18; scales 46-48 in median lateral series; 12-13 in transverse series; 17-18 predorsals; abdominal scutes, 17 preventrals, 15-16 postventrals.

Body well compressed, dorsal profile slightly convex; ventral profile sharp, more convex than upper. Caudal peduncle 2.5

in head, compressed, least depth equals its length. Head width twice its length. Snout width about 1.3 its length which is 3.5 to 3.6 in head. Eye advanced, 3.5 in head. Maxillary reaches to below anterior third of eye. Teeth absent on jaws. Interorbital flat, 4.5 in head; venules on vertex. Gill rakers 65 to 73, finely lanceolate, about 0.7 in eye, about 1.3 times gill filaments. Pseudobranchiæ 17. Scales largely adherent, often irregular; crenulate, fenestrate, distinctly pectinate; 4 or 5 vertical striæ, 1 complete.

Base of dorsal embedded in scaly sheath; origin much nearer snout tip than caudal base; longest ray 1.3 in head. Pectorals about twice ventrals. Ventral below middle of dorsal, nearer pectorals than anal, 2.5 to 2.7 in head. Anal low, depressible among scaly flaps, 1.8 in head.

The structure of the scales of this species is close to that of the scales of *S. perforata*, but the latter has a distinctly deeper body.

This description is based on No. 41167, 111 mm, obtained from Tondo, Manila, Luzon, October 18, 1930.

Luzon, Bulacan Province, Malolos, No. 15386, 111 mm, April 9, 1927; No. 21252, 94 mm, April 19, 1927: Rizal Province, Malabon, No. 649, 103 mm, July 18, 1907: Manila, Manila market, No. 88, 102 mm, May 31, 1907; No. 106, 112 mm, June 1, 1907; Nos. 211-212, 99-104 mm, June 12, 1907; Manila, No. 3, 83 mm, May 20, 1907; Nos. 6869-71, 6873, 6890, 48-123 mm, June, 1910; Nos. 11535, 21265-68, 47-66 mm, April 14, 1913; Paco Market, No. 11387, 114 mm, September 19, 1919; Tondo, Nos. 41168-73, 94-107 mm, October 18, 1930: Cavite Province, Cavite, No. 127, 68 mm, May, 1907. MINDORO, Mindoro Province, Calapan, Nos. 21246-47, 14204, 21249-50, 75-100 mm, January, 1923. Panay, Iloilo Province, Estancia, Nos. 16177, 21253-57, 75-104 mm, August 12, 1927; Nos. 21235-39, 94-101 mm, July 19, 1927; Nos. 21431-33, 92-98 mm, July, 1922.

## SARDINELLA PERFORATA (Cantor). Lapad or halubaybay. Plate 2, fig. 10.

Clupeonia perforata CANTOR, Journ. Asiat. Soc. Bengal 18 (1850) 1276.

Spratella kowala BLEEKER, Nat. Tijdschr. Ned. Ind. 2 (1851) 492. Harengula (Spratella) kowala BLEEKER, Versl. Akad. Ams. 2 (1868) 294.

Clupea perforata Günther, Cat. Brit. Mus. 7 (1868) 424.

Clupea (Harengula) perforata BLEEKER, Atl. Ichth. 6 (1872) 110; Weber and De Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 74.

Sardinella perforata EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 54; FOWLER, Proc. Acad. Nat. Sci. Phila. 58 (1911) 206.

Head 3.6; depth 3.2; dorsal 18; anal 22; scales 41-46 in median lateral series; 11-13 in transverse series; predorsals 17-18; abdominal scutes, 16-18 preventrals, 12 postventrals, sharp, prominent.

Body spindle-shaped, compressed as in *S. fimbriata*, but deeper; dorsal and ventral profiles smoothly convex, more than that of *S. fimbriata*. Vertex flat, straight. Caudal peduncle deep; least depth 1.3 times its length, about 2.5 in head. Head width 2 in its length. Snout suppressed, width nearly equal length which is 3.7 in head. Eye advanced, about 3 in head. Maxillary 2.3 to 2.5 in head, extends beyond anterior margin of orbit. Interorbital slightly convex, 3.7 in head; vertex veined. Gill rakers 66, fine, lanceolate, 1.8 in orbit; gill filaments 1.2 to 1.3 in gill rakers. Pseudobranchiæ equal, 18. Scales crenulate, pectinate, distinctly fenestrate, with large, rounded holes; 4 to 5 transverse striæ, 1 complete.

Base of dorsal embedded in scaly sheath; origin nearer snout than caudal base; height 1.4 in head. Pectorals 1.2 head, twice ventrals. Ventral origin slightly in advance of middle of dorsal, nearer pectorals than anal, 2 in head. Anal low, its two last rays extensive; base 1.6 in head.

This species differs from S. fimbriata in having a deeper body, a greater and more prominent curvature of the ventral profile, and in having characteristic scales.

The above description is based on No. 6874, 101 mm, Manila Bay, Manila, Luzon, June, 1910.

Luzon, Manila, Manila market, Nos. 210, 275, 365, 83–90 mm, June 12–14, 1907; Nos. 11551, 21242–45, 72–102 mm, December 18, 1924; Manila, Nos. 6872, 6875–89, 56–103 mm, June, 1910: Rizal Province, Pasay, Nos. 12177, 21522–27, 72–85 mm, October 17, 1925: Cavite Province, Cavite, Nos. 118–19, 153, 80–83 mm, May 21, 1907; Salinas, Nos. 41174–78, 100 mm, October 1, 1930: Camarines Sur Province, Cabusao, Nos. 11917, 21509–14, 67–93 mm, December 21, 1918: Sorsogon Province, Bacon, Nos. 3660–61, 94–102 mm, 1904. Panay, Iloilo Province, Estancia, Nos. 16181, 21239, 97–93 mm, July 19, 1927.

SARDINELLA LONGICEPS Cuvier and Valenciennes. Tamban; tamban lison; tuloy. Plate 2, fig. 1.

Sardinella longiceps Cuvier and Valenciennes, Hist. Nat. Poiss. 20 (1847) 198; Fowler, Proc. Acad. Nat. Sci. Phila. 79 (1927) 257. Sardinella neohowii Cuvier and Valenciennes, Hist. Nat. Poiss. 20 (1847) 198.

Alosa scombrina Cuvier and Valenciennes, Hist. Nat. Poiss. 20 (1847) 324.

Sardinella lemuru BLEEKER, Nat. Tijdschr. Ned. Ind. 4 (1853) 500. Clupea lemuru GÜNTHER, Cat. Brit. Mus. 7 (1868) 430. Clupea scombrina GÜNTHER, Cat. Brit. Mus. 7 (1868) 448. Clupea (Harengula) lemuru BLEEKER, Atl. Ichth. 6 (1872) 108. Clupea longiceps DAY, Fishes of India 4°. (1878–1888) 637. Clupea (Harengula) longiceps WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 82.

Clupea (Harengus) longiceps Deraniyagala, Spolia Zeylonica 15 (1929) 44.

Head 3.25-3.5; depth 4; dorsal 17; anal 13-15; scales 44-47 in median lateral series; 13-14 in transverse series; 13-16 predorsals; ventral scutes, 14-17 preventrals, 14-17 postventrals.

Body slightly compressed, fusiform. Least depth of caudal peduncle nearly equals its length, 3.5 in head. Head width 2.2 to 2.3 in its length; snout width 1.3 to 1.5 its length which is 3.5 in head measured from tip of upper jaw. Eye 4 to 4.2. Maxillary 2.3 in head, nearly reaches below middle of eye. Interorbital flat, about 5 in head. Cheek with prominent striæ on preopercle and operculum. Gill rakers 142 to 171, smooth, finely lanceolate, about 1.2 in eye, about twice gill filaments. Scales largely adherent, crenulate, entire, with 4 to 5 vertical striæ, 1 complete.

Dorsal and anal depressible in basal scaly flaps; dorsal origin nearer snout than caudal base; dorsal 2.2 to 2.3 in head. Pectorals about twice ventrals, 1.7 in head. Ventrals inserted below middle of dorsal origin, nearer anal than pectorals, 3.3 in head. Anal low, its base 2.5 in head, last ray well developed.

This species has a much longer and thicker body than most other species of the genus. It also grows much larger.

The above description is based on Nos. 41163 and 41164, 89-103 mm, Estancia, Iloilo Province, Panay, July, 1927.

Luzon, Ilocos Sur Province, Santa Maria, Nos. 11200, 21494–96, 94–101 mm, January 23, 1923: Manila, Manila market, No. 18, 140 mm, January 16, 1908: Batangas Province, Nasugbu, Barrio Papaya, No. 13265, 155 mm, January 13, 1926. Polillo, Tayabas Province, Polillo, No. 12597, 181 mm, September 25, 1925. Mindoro, Mindoro Province, Pinamalayan, No. 6821, 158 mm, January, 1913; Calapan, No. 11423, 129 mm, January 16, 1923; Bulalacao Bay, No. 14626, 161 mm, December 20, 1926. Leyte, Leyte Province, Cabalian, Nos. 9644 and 21414, 113 mm, June 1, 1921; Carigara, Nos. 7897–99, 69–75 mm, December 11, 1913. Panay, Iloilo Province, Estancia, Nos. 11261, 21346–78, 128–146 mm, September, 1924; Nos. 12161, 12193, 21398–99, 21400, 21491–93, 119–146 mm, July 17, 1925;

Nos. 16183, 21269-77, 89-103 mm, June 21, 1927. NEGROS, Negros Oriental Province, Dumaguete, No. 21436, 167 mm, March 15, 1927. CAMIGUIN, Misamis Province, Catarman, No. 21440, 168 mm, February 10, 1927. MINDANAO, Zamboanga Province, Zamboanga, Nos. 4115, 4123, 4128, 4140, 90-100 mm, May 22, 1908; No. 4420, 107 mm, June 12, 1908; No. 2868, 93 mm, April 9, 1908; Dipolog, Nos. 15019, 21504-07, 108-119 mm, March 14, 1927.

## Genus HARENGULA Valenciennes

Body oblong or partly oblong; abdominal scutes with distinct spine or smooth; edge of upper jaw without median notch; vomerine teeth always absent; scales firmly adnate, thin, with transverse striæ continuous or overlapping; dorsal with low scaly basal sheath; hind anal rays equal, not enlarged.

Key to the Philippine species of Harengula.

- a. Scales in median lateral series less than 40.
  - H. dispilonotus (Bleeker).
- $a^2$ . Scales in median lateral series more than 40.
  - b. Gill rakers less than 50.... H. moluccensis (Cuvier and Valenciennes).

#### HARENGULA DISPILONOTUS Bleeker. Plate 2, fig. 12.

Harengula dispilonotus BLEEKER, Nat. Tijdschr. Ned. Ind. 3 (1852) 456.

Clupea dispilonotus GÜNTHER, Cat. Brit. Mus. 7 (1868) 429; MAX WEBER, Fische Siboga Expeditie 65 (1913) 9.

Clupea (Harengula) dispilonotus BLEEKER, Atl. Ichth. 6 (1872) 112. Harengula dispilonotus Fowler, Proc. Acad. Nat. Sci. Phila. 85 (1933) 246.

Harengula dispilonotus HERRE, Fish. Herre 1931 Philip. Exp. (1934) 15.

Head 3.6-3.7; depth 3-3.2; dorsal 17-18; anal 19-20; scales 32-34 in median lateral series; 10 in transverse series; 15 preventral scutes; 12-13 postventrals.

Body oblong, well compressed, with trenchant abdomen lined by sharp, prominent scutes; ventral profile slightly more concave than dorsal. Caudal peduncle short, about half its least depth, less than eye diameter. Snout slightly less than eye, about 3.2 in head measured from tip of upper jaw. Maxillary reaches to below front margin of pupil. Interorbital equal, orbit flat, forming with protruding snout tip a concavity on head profile. Gill rakers 42 to 45, finely lanceolate, slightly compressed, spinous; longer than filaments, slightly longer than radius of orbit. Scales rather deciduous, round, with 3 to 6 vertical stria-

tions, all complete; similar to scales of *H. moluccensis*; margins rarely serrate. Dorsal origin 1.3 nearer snout than caudal base. Length nearly equals height, equals head without snout. Anal low, twice length of caudal peduncle, 1.6 in head. Pectorals equal base of dorsal. Ventrals 1.4 times orbit, slightly nearer anal than pectorals, below middle of dorsal.

With two characteristic dark brown spots, one at about last third of dorsal and another about an orbit posterior to the former.

MINDORO, Mindoro Province, Mangarin, No. 10976, 90 mm, 1913. PANAY, Iloilo Province, Iloilo, Nos. 14242, 21395-21397, 112 mm, July 2, 1922. BALABAC, Palawan Province, Balabac, Nos. 5014-5041, 21218, 21219, 51-54 mm, August 3, 1908.

#### HARENGULA MOLUCCENSIS Bleeker. Plate 2, fig. 3.

Harengula moluccensis BLEEKER, Nat. Tijdschr. Ned. Ind. 4 (1853) 609; JORDAN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 4; EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 53; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 239.

Harengula kunzei BLEEKER, Nat. Tijdschr. Ned. Ind. 12 (1856-1857) 209.

Clupea moluccensis Günther, Cat. Brit. Mus. 7 (1868) 427.

Clupea (Harengula) moluccensis BLEEKER, Atl. Ichth. 6 (1872) 107; Weber and de Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 81.

Clupea (Harengula) kunzei BLEEKER, Atl. Ichth. 6 (1866-1872) 107. Clupea kunzei DAY, Fishes of India 4°. (1878-1888) 636; GÜNTHER, Fische der Südsee 8 (1909) 382.

Clupea (Harengus) moluccensis Deraniyagala, Spolia Zeylanica 15 (1929) 43.

Head 3.8; depth 3.6; dorsal 18-19; anal 17; scales 42-45 in median lateral series; 12-13 in transverse series; 12-13 predorsals; abdominal scutes, 17 preventrals, 12-13 not prominent postventrals.

Body compression and depth intermediate between S. fimbriata and S. perforata; fusiform; dorsal profile more convex than ventral. Ventral edge not sharp, as in S. fimbriata, less trenchant than that of S. perforata. Caudal peduncle shorter than deep, least depth 1.7 times length, about 2.6 in head. Head width twice length, thicker than any portion of body. Snout width greater than length, forming with eye and preorbital a deep concavity; width 3.7 in head. Eye advanced, about 3 in head. Maxillary 2.1 in head, reaches to below first third of eye. Interorbital slightly concave, depressed towards tip; vertex with few venations. Cheek extensively veined. Gill rakers 36 to 41.

length about 2 in orbit, equal to gill filaments. Pseudobranchiæ equal, 14 to 15. Scales strongly adherent, crenulate, entire, irregularly serrate; 4 to 6 transverse striæ, all, or almost all, complete.

Dorsal origin nearer snout tip than caudal base; longest ray about 1.7 in head. Pectoral 1.7 in head, 1.6 times ventrals. Ventrals inserted slightly in front middle of dorsal, equidistant from pectorals and anal; 1.8 in head. Anal depressible in scaly flaps, low, last two rays well developed; anal base 1.7 in head, equals dorsal base.

The above description is based on Nos. 2358 and 2429, 98 and 106 mm, obtained from Jolo Island, Sulu Province, February, 1908.

LUZON, Ilocos Norte Province, Bangui, Nos. 14340, 21515-19, 85 mm, August 19, 1926: Zambales Province, Olongapo, Nos. 150-151, 88 mm, May, 1907: Batangas Province, Balayan Bay, No. 2339, 90 mm, January 20, 1908: Cavite Province, Cavite, No. 128, 103 mm, May, 1907. PANAY, Iloilo Province, Estancia, No. 21434, 62 mm, July, 1922. CEBU, Cebu Province, Cebu, No. 1258, 28 mm, September 5, 1907. PALAWAN, Palawan Province, Puerto Princesa, Nos. 5487-88, 60-63 mm, August 4, 1908; Nos. 213311-12, 57 mm, August 21, 1908: BALABAC, Palawan Province, No. 21298, 57-72 mm, August 10, 1908. CAMIGUIN. Misamis Province, Camiguin, No. 608, 89 mm, June, 1907. DANAO, Misamis Province, Cagayan, No. 1521, 48 mm, September 9, 1907; No. 1543, 84 mm, September 12, 1907; Surigao Province, Surigao, No. 1772, 57 mm, September 17, 1907. Bungau, Sulu Province, Bungau, Nos. 11382, 21497-99, 87-91 mm, August SIBUTU, Sulu Province, Sibutu, Nos. 13731, 21401-05, 98-108 mm, May 3, 1926.

#### HARENGULA TAWILIS Herre. Tawilis. Plate 2, fig. 15.

Harengula tawilis HERRE, Philip. Journ. Sci. 34 (1927) 273, pl. 3, figs. 1-6.

Head 4.2-4.5; depth 3.2-3.6; dorsal 18-19; anal 20-21; scales 40-42 in median series; 11-12 in transverse series; 11-13 predorsals; 16-18 preventrals, 11 postventrals.

Body compression, dorsal profile, and convexity similar to those of *S. perforata*; ventral profile slightly more convex, but as trenchant; body deeper. Caudal peduncle compressed, least depth 1.4 times its length. Snout width 1.2 in its length which is 3.5 in head, measured from tip of snout. Eye advanced, 3.4 in head. Maxillary reaches below third of eye, 2.3 in head.

Interorbital slightly convex, veined. Gill rakers 58 to 60, spinulose, lanceolate, 1.8 in orbit, 1.2 in gill filaments. Pseudobranchiæ 16, equal. Scales very adherent, regular, entire. Transverse striæ 4 to 6, most commonly 5, 1 to 3 continuous, the rest discontinuous, the central terminals running past each other.

Dorsal fin depressible in a sheath of scales; origin nearer snout tip than caudal base; longest ray 1.4 to 1.5 in head. Pectorals 1.6 times ventral which is 2.2 in head. Ventral origin below middle of dorsal, nearer to pectorals than to anal. Anal low, base about twice length of caudal peduncle, 1.6 in head, isometric with dorsal base.

Scales closest to those of *H. moluccensis* but differ in being less elliptical; in having several discontinuous, though overreaching, transverse striæ; in being crenulate; and in being more, though irregularly, pectinate.

The above description is based on Nos. 21316, 21317, and 21325, 85-114 mm, Lake Bombon (Taal), Batangas Province, November 8, 1925.

Luzon, Batangas Province, Bombon Lake (Taal) Nos. 15157, 23947, 26983, 89-110 mm, April, 1927; Nos. 21383, 21387, 10801, 85-90-92 mm, February 17, 1921; Nos. 13198, 21318-45, 21327, 21345, 85-115 mm, March 1, 1926; Nos. 14237, 21314-26, 97-114 mm, November 8, 1925.

## Genus ILISHA (Gray) Richardson

Body oblong, much compressed. Scales thin, deciduous. Lower jaw prominent, mouth cleft oblique. Upper pectoral ray strong and broad, anal very long with 35 to 54 rays, its origin below or just behind dorsal; ventrals small, its origin in advance of dorsal. Gill rakers stout, few (about 20) spinulous all around.

One Philippine species is known.

#### ILISHA HOEVENII Bleeker. Tuabak. Plate 2, fig. 9.

Pellona hoevenii BLEEKER, Verh. Bat. Gen. 24 (1852) 21; DAY, Fishes of India 4°. (1878-1888) 644.

Pellona hoevenii Günther, Cat. Brit. Mus. 7 (1868) 455.

Ilisha hoevenii Bleeker, Atl. Ichth. 6 (1872) 117; Jordan and Seale, Bull. U. S. Bur. Fish. 26 (1906) 5; Evermann and Seale, Bull. U. S. Bur. Fish. 26 (1906) 54; Jordan and Richardson, Bull. U. S. Bur. Fish. 27 (1907) 236; Fowler, Copeia No. 58 (June, 1918) 62; Proc. Acad. Nat. Sci. Phila. 79 (1927) 258.

Head 3.3-3.4; depth 2.7-2.9; dorsal 18; anal 36; scales 42-44 in median lateral series; 11-12 in transverse series, 10 predorsals; 27 prominent abdominal scutes, 18 being preventrals.

Body strongly compressed, deep; ventral profile more convex than dorsal; ventral edge cultrate with sharp, firm, serrature. Caudal peduncle well compressed, deep, 1.6 to 1.8 in its least depth which is 2.8 in head measured from tip of lower jaw. Head width 2 in its length. Snout width greater than length. about 3 in head. Eye advanced, 2.5 to 2.7 in head, 2.6 times snout length; maxillary extends to pupil of eye, about 1.3 times eye diameter, twice head length; distal margin of accessory bone and maxillary finely denticulated throughout; snout, with orbit, preorbital, postorbital, and interorbitals, forms a deep concavity. Teeth on intermaxillary small, but larger than those of accessory maxillary. Teeth present also in lower jaw, tongue, palatine, and pterygoid. Interorbital somewhat concave, with a prominent pair of furrowed ridges which meet posteriorly about an orbit past occiput: vertex not conspicuously veined. Gill rakers 20 to 23, coarsely lanceolate, spiny on upper margin, firm; 1.3 to 1.5 in gill filaments, about 5 in orbit. dobranchiæ 20 to 22, all equal. Scales very deciduous, large, commonly subcordate, smooth, entire, unimbricated portion usually produced to an obtuse point; 4 to 6 transverse striæ, one complete, others interrupted at midportion.

Dorsal origin raised on summit of a sharp, firm keel, midway between tip of upper jaw and caudal base; behind ventrals; base length isometric with longest ray, 1.6 in head from maxillary tip, 2.3 in body depth. Caudal deeply forked. Pectorals 2.2 times ventrals, greater than dorsal base, 1.5 in head, 1.8 times its axillary scale. Ventral insertion midway between pectoral and anal origin, small; length less than an orbit. Anal low, elongate, longer than head, twice dorsal base; origin slightly behind last dorsal ray. Anal opening deeply indented behind last abdominal scute.

This species differs from all other forms of *Ilisha* in having a supplemental bone instead of a ligament between the lateral end of intermaxillary and upper end of maxillary.

The above description is based on Nos. 7810-12, 118-134 mm, Carigara, Leyte Province, Leyte Island, November 11, 1913.

Luzon, Manila, Manila market, No. 364, 96 mm, January 20, 1907; Manila, No. 6810, 108 mm, June, 1910; Divisoria market, No. 41180-81, 116-125 mm, November 15, 1930. MINDORO, Mindoro Province, Calapan, No. 21251, 60 mm, 1923. MASBATE, Masbate Province, Masbate, No. 14244, 119 mm, June 2, 1925. Leyte, Leyte Province, Carigara, Nos. 7803, 7814-15, 7812-18, 7820, 7850, 7855, 118-134 mm, November 11, 1913. Panay,

Antique Province, Culasi, Nos. 41112, 41179, 80-94 mm, December 15, 1933. Guimaras, Iloilo Province, west coast of Guimaras Island, Nos. 41311, 41325 (82 specimens), 41328 (93 specimens), 41331 (86 specimens), 27-33 mm, December 18, 1933.

## STERNOPTYCHIDÆ 1

Body short, anterior portion elevated, compressed or elongated, with "carinated contour." Eyes large, sometimes telescopic. Without barbels. Gape of mouth vertical or nearly so with upper margin constituted by the supramaxillaries and intermaxillaries. Dorsal may be preceded by spines, located about middle of body. Adipose fin low, totally or partly above hind part of anal which may be divided. Ventrals small, below or before origin of dorsal. Scales present or absent; if present, large, thin, and very deciduous. Preorbital, postorbital, and ocular luminous organs single; those on body in groups. No whitish punctiform organs on fins. Branchiostegals 5 to 11; arch near to and parallel with lower jaw. Gill rakers well developed. Pseudobranchiæ present or absent.

"Deep sea fishes, rising toward the surface at night or in stormy weather." (Jordan and Evermann, 1896).

Key to the Philippine genera of Sternoptychidæ.

- a 1. Body much elevated, compressed, short, height about 1.5. Anal short,
   11 to 17 rays. Pseudobranchiæ present. Eyes normal.

  - b an abrupt ventral constriction between trunk and tail which is filled by a transparent integumentary plate resembling thin cartillage. No teeth on vomer. Branchiostegals 5.

Sternoptyx Hermann.

a<sup>3</sup>. Body elongate, not elevated, scaleless, height about 3.7 to 3.8. Anal long, 23 to 24 rays. Dorsal short, not preceded by a strong spine or hyaline plate. Caudal emarginate. Eyes normal, pseudobranchiæ wanting ................................... Valenciennellus Jordan and Evermann.

The record of Philippine deep-sea fishes is very incomplete. Aside from the little work done by the "Challenger" in 1873-76, no collection of the deep-sea fishes has been made in and around the Philippines.

<sup>1</sup> After Günther (1887), Jordan and Evermann (1896) and Weber and de Beaufort (1913).

### Genus POLYIPNUS Günther

Body elevated, strongly compressed, ventral portion between trunk and tail without abrupt constriction; covered with large, very thin, and deciduous scales. Dorsal fin without anterior spinous dilation but preceded by a forked spine. Anal not divided, short, with 15 to 17 rays. Adipose fin low. Eyes normal, large. Teeth on vomer. Branchiostegals short, 9 to 11. Gill rakers rather long.

One Philippine species is known.

#### POLYIPNUS SPINOSUS Günther.

Polyipnus spinosus GÜNTHER, Rep. Voyage "Challenger," Deep-Sea Fishes (1887) 170; Alcock, Ann. & Mag. Nat. Hist. (VI) 4 (1889) 137-398; Brauer, Deutsche Tiefsee Exp. Tiefseefische (1906) 120; MAX WEBER, Fische Siboga Expeditie 65 (1913) 22; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 130-131.

Head 3; depth 1.3-1.8; dorsal 12-13; anal 15-17; pectoral 12-14; ventral 5.

Head much higher than long, 2.5. Vertical diameter of eye 0.5 or somewhat more of length of head. Snout very short, less than pupil. Dorsal part of head with 2 serrated ridges, each beginning behind nostril and bordering a concave space, then converging towards middle of occiput and continuing as strong, diverging crests, ending in a sharp recumbent spine. Edge of preoperculum armed with a slender, clawlike spine, pointing vertically downward and serrated near its angle. Gape of mouth vertical, bordered above by slender intermaxillary and maxillary. Hinder half of latter broad, rounded behind the gape. Mandibles received within the upper jaw, their lower border denticulated. A band of minute, curved teeth on intermaxillary and mandibles, and a single series on maxilla; similar teeth on vomer. Symphysis and its inferior posterior angle with a blunt spine.

Ventral edge of body serrated, with an anterior and posterior spine, followed by a spinulous edge on each side between ventrals and anal. Origin of dorsal near middle of body, preceded by a small bifid spine. Origin of anal on posterior third of body. Low adipose fin midway between dorsal and caudal. Pectorals low in position, reaching almost as far as base of small ventrals. Anus immediately before anal. Caudal forked. Extremely thin, large, deciduous scales. Luminous organs: an oval black spot on preorbital before middle of eye, a postorbital one on the same level, a suborbital below middle of eye; a small

opercular below level of suborbital; 6 between branchiostegal rays; a series of 6 between isthmus and base of pectorals; a series of 10 along ventral edge, between humeral and pelvic symphysis; 5 between ventrals and anal; a series of 6 to 12 above and behind anal and a series of 4.5 behind there decreasing in size posteriorly, the last above the first caudal ray; 2 above and 3 behind base of pectorals; 2 on side of trunk below middle line. Silvery, back yellowish brown. Length 85 mm.

The type species of the genus *Polyipnus* Günther (1887) is *P. spinosus*. The type specimen was obtained by the "Challenger" at Station 200, between the Philippine Islands and Borneo, at a depth of 250 fathoms.

This species is not represented in the collection. The above description is based on that of Günther (1887).

#### Genus STERNOPTYX Hermann

Trunk much elevated and compressed, slender tail very short; with an abrupt ventral constriction between trunk and tail which is filled by a transparent integumentary plate. Greater portion of body scaleless and covered with a silvery pigment. Dorsal fin preceded by a large triangular transparent plate. Anal short, 11 to 17 rays, undivided, incompletely developed. Adipose fin represented by a very low membranous fringe of the dorsal margin of tail. Teeth on jaws in several series, the largest teeth in a single row. No teeth on vomer. Eyes large, normal, lateral. Pseudobranchiæ present. Gill rakers moderate. Branchiostegals 5.

One Philippine species is known.

#### STERNOPTYX DIAPHANA Hermann.

Sternoptyx diaphana Hermann, Der Naturforscher 16 (1781) 8; GMELIN, Syst. Nat. Linnæus (1789) 1150; GÜNTHER, Cat. Brit. Mus. 5 (1864) 387; GOODE and BEAN, Bull. Mus. Comp. Zool. 10 No. 5 (1833) 220; GÜNTHER, Rep. Voyage "Challenger" Deep-Sea Fishes (1887) 168; GILBERT and CRAMER, Proc. U. S. Nat. Mus. 19 (1897); BRAUER, Deutsche Tiefsee Exp., Tiefseefische (1906) 115; GILBERT, Bull. U. S. Fish. Comm. 23 pt. 2 (1903) 609; ZUGMAYER, Camp. Scient. Monaco 35 (1911) 54; MAX WEBER, Fische Siboga Expeditie 65 (1913) 22; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 132; FOWLER, Mem. B. P. Bishop Mus. 10 (1928) 35. Sternoptyx hermanni LACÉPÈDE, Hist. Nat. Poiss. 5 (1803) 613.

Dorsal 12; anal 14; head 2.6-2.8 measured along axis connecting tip of snout and lateral center of caudal peduncle; depth 1.4-1.7, taken at right angle to snout-caudal axis. Body deep, strongly compressed; belly pushed considerably downward and

forward beneath head, pectoral portion being protracted to below snout. Ventral portion of trunk abruptly narrow almost perpendicularly to a short, small, and much more compressed tail. Narrow ventral margin reaches to same level with eye, and tail region extends above level of head. Lower part between trunk and tail occupied by a transparent integumentary portion whose entire ventral margin bears the transparent anal fin. Ventral profile much more convex than dorsal and its contour disturbed by marginal spines borne on protuberances which they intensify to acuteness. A strong, hyaline, unpaired spine at angle formed by the oblique isthmus and the straight ventral margin of trunk. Two bifid closely set spines on pelvic symphysis on posterior portion of ventral margin of trunk. Anterior spine long, directed forward; posterior one short, directed posteriorly. but deep, triangular, with opercular margin at longest side, and occiput as point of acute angle, the whole triangle slightly tipped backward on its upper portion. Cleft of mouth subvertical. more or less concave, with tip of snout looming forward. extremely short, bordered by much reduced intermaxillary and maxillary. Lower jaw received in upper jaw; dentine translucent; postero-inferior angle with a short spine. Unequal minute teeth on margins of both jaws. Eye large, orbital socket oval, with greatest diameter on dorsoventral axis; located above and slightly advanced from symphysis of jaws; equal oral cleft. terorbital narrow, slightly wider than the pupil. Vertex from snout tip to occiput, about equal straight ventral margin of trunk, steep, more or less straight, made concave by 2 prominent, serrate, hyaline, ridges which arise from snout tip passing low on upper margin of orbit and meeting at occipital region. Operculum proportionately drawn out dorsoventrally; soft, membranous; opercular opening correspondingly wide. Posterior limb of preopercle bordering hind part of orbit, and descending Trunk semihvaline, its ventral side straight and keeled by a sharp, transparent lamina. Pectorals well developed, carried down to below eve with drawn thorax, barely reaching ventrals. Ventrals small, arising behind bifid spines, and received in a shallow, concave recess. A long, sharp, hyaline spine behind recess where trunk climbs to a perpendicular. Anal long, rays rudimentary, in the form of a transparent plate supported by externally visible interhæmal rays. Dorsal origin immediately or slightly behind superior pelvic symphysis, with a prominent spine strengthened in front by a sharp triangular lamella. Lamella less finely serrate than verticle ridges, originating immediately behind rhomboid flat area which marks the occiput. Lamella has a spine which is directed backward. Adipose fin represented by a low hyaline keel which runs continuous with dorsal margin of caudal. Caudal hyaline, broad, forked; peduncle oblique, running about 45° with level of trunk. Scales absent. Gill rakers 14, tuberculate, widely spaced, about length of gill filaments.

General body color dirty brown.

#### LUMINOUS ORGANS

A series of luminous spots runs along the lower edge of the abdomen, and is separated from that of the other side by a cartilaginous fold occupying the median line of the abdomen; another series runs on each side of the isthmus; a row of three above and behind the root of the ventrals, and another row of three above the vent. The luminous organs on the lower part of the tail consist anteriorly of a row of four, of which the first is prolonged towards the back as a narrow band, terminating about the middle of the depth of the body in a globular spot with a white centre; posteriorly in front of the caudal rays there is another row of four small spots . . . . A luminous organ occupies the inner side of the operculum close to its lower end; another is placed at the anterior end of the ceratohyal, and, finally, a very large glandular mass is lodged on the upper edge of the anterior end of the clavicle . . . . (Günther, 1887.)

The above description is based on one specimen, No. 15983, 27 mm, collected by the Danish Scientific Expedition, June 16, 1929, at its Station No. 3731, XIV, 119° 52′ E. Long. 14° 37′ N. Lat. about 60 miles NWW off Lubang Island, Mindoro, at a depth of 1,000 meters.

## Genus VALENCIENNELLUS Jordan and Evermann

Body elongate, not elevated, strongly compressed, scaleless. Head strongly compressed; mouth wide, subvertical, maxillary broad, curved. Teeth on jaws. Luminous organs on head; a ventral series between isthmus and ventrals and between ventrals and anal, the organs touching each other; between origin of anal and caudal five groups of organs on rather large black patches. Dorsal short, not preceded by strong spine. Adipose fin low, distinct, immediately behind dorsal. Caudal emarginate. Anal long, undivided, with 23 to 24 rays. Eyes normal, large, lateral. Pseudobranchiæ wanting.

One Philippine species is known.

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#### VALENCIENNELLUS TRIPUNCTULATUS (Esmark).

Maurolicus tripunctulatus ESMARK, Vidensk. Selskaps Forhandl. Christiana (1870) 488; LÜTKE, Spolia Atlantica, Scopelini (1892) 269.

Valenciennellus tripunctulatus Jordan and Evermann, Fishes of North and Middle America 1 (1896) 278; Max Weber, Fische Siboga Expeditie 65 (1913) 20; Weber and De Beaufort, Fish. Indo-Austr. Arch. 2 (1913) 136.

Head 3.3-3.7; depth 3.7-3.8; dorsal 7; anal 24; pectoral 10; ventral 7.

Body elongate, tapering posteriorly. Eye 2.5, about equal snout. Gape of mouth very oblique, nearly vertical. Both jaws with minute teeth. No teeth on vomer. Origin of dorsal opposite first rays of anal, in the middle of the length. Pectorals about 0.7 to 0.8 of head, reach to ventrals which are short. Scales wanting.

#### LUMINOUS ORGANS

Luminous organs: 16-17 organs, touching each other, in a ventral series between isthmus and ventrals. A lateral series of 10, four of which before pectorals, the fifth above the pectorals, 2 somewhat smaller ones, close together, behind the pectorals and followed at a short distance by the larger 3 equally distant, hindermost. Between ventrals and anal a series of 5, touching each other. These and the lateral series of organs consists of round organs, partly silvery, partly blackish, bordered by a metallic reddish patch above. Between origin of anal and caudal 5 equally distant black spots the first, second and third containing 3 white rounded organs, the fourth 2, and the fifth 4; an antorbital organ below nostril, a series of 4 organs underneath the cheek; 2 opercular ones, one behind the eye and one behind the maxilla, 2 or 3 on the gill membrane. Brownish operculum and belly silvery. A series of about 15-17 black spots between operculum and caudal . . . (Weber and the Beaufort, 1913, p. 137.)

This species is represented in the collection by No. 15984, a single, mutilated specimen, 26 mm long, collected by the Danish Scientific Expedition June 16, 1929, at Station No. 3731, VI, 119° 52′′ E. Long. 14° 37′ N. Lat. about 60 miles NWW off Lubang Island, Mindoro, at a depth of 1,000 meters.

As far as is known this is the first locality record of *V. tripunctulatus* from Philippine waters.

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# **ILLUSTRATIONS**

## PLATE 1. SCALES OF PHILIPPINE ISOSPONDYLOUS FISHES

- Fig. 1. Nematalosa nasus,  $\times$  6.
  - 2. Dussumieria hasseltii,  $\times$  6.
  - 3. Chanos chanos,  $\times$  5.
  - 4. Megalops cyprinoides,  $\times$  3.
  - 5. Dussumieria acuta,  $\times$  6.
  - 6. Thrissocles setirostris,  $\times$  6.
  - 7. Thrissina baelama,  $\times$  6.
  - 8. Scutengraulis mystax,  $\times$  6.
  - 9. Chirocentrus dorab,  $\times$  6.
  - 10. Scutengraulis hamiltonii, × 3.
  - 11. Elops hawaiensis,  $\times$  9.
  - 12. Albula vulpes,  $\times$  3.
  - 13. Anodontostoma chacunda,  $\times$  5.

## PLATE 2. SCALES OF PHILIPPINE ISOSPONDYLOUS FISHES

- Fig. 1. Sardinella longiceps,  $\times$  6.
  - 2. Sardinella jussieu,  $\times$  5.
  - 3. Harengula moluccencis,  $\times$  5.
  - 4. Sardinella sirm,  $\times$  5.
  - 5. Sardinella fimbriata,  $\times$  6.
  - 6. Stolephorus commersonii,  $\times$  6.
  - 7. Clupeoides lile,  $\times$  6.
  - 8. Stolephorus indicus,  $\times$  6.
  - 9. Ilisha hoeveni,  $\times$  6.
  - 10. Sardinella perforata, × 4.
  - 11. Sardinella samarensis,  $\times$  6.
  - 12. Harengula dispilonotus,  $\times$  6.
  - 13. Sardinella melanura.
  - 14. Stolephorus tri,  $\times$  6.
  - 15. Harengula tawilis,  $\times$  6.

#### PLATE 3

- Fig. 1. Anodontostoma chacunda; head,  $\times$  1.
  - 2. Nematalosa nasus; head,  $\times$  1.
  - 8. Clupanodon punctatus; head,  $\times$  1.



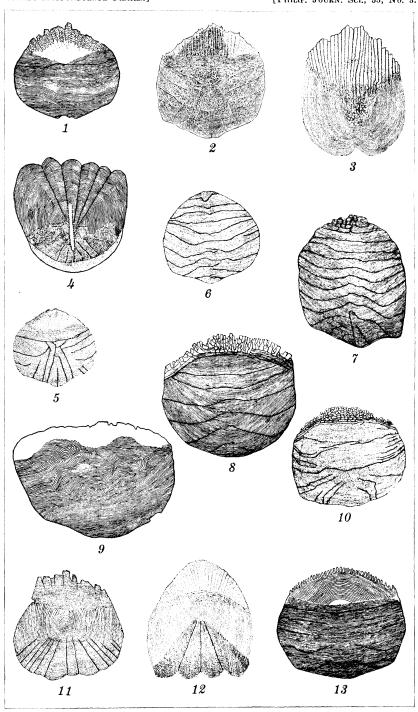


PLATE 1.

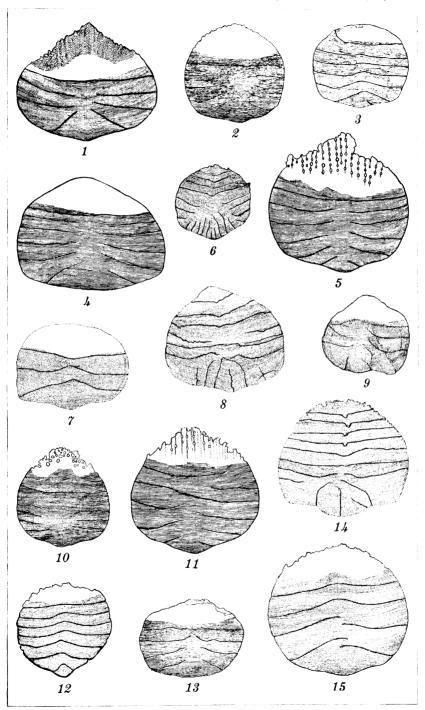


PLATE 2.



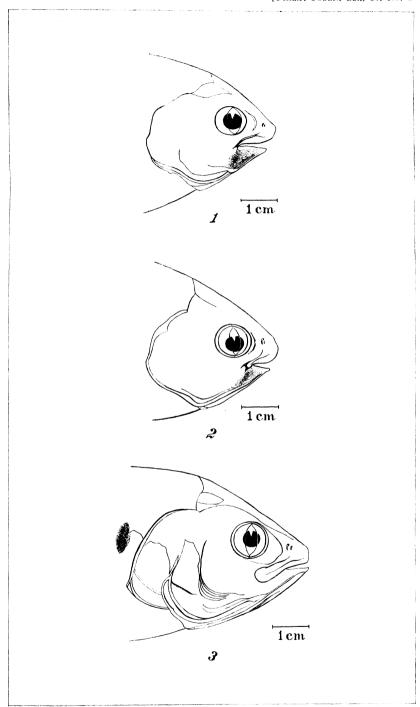


PLATE 3



# THE PHILIPPINE JOURNAL OF SCIENCE

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# HABITATS OF PHILIPPINE ANOPHELES LARVÆ 1

By PAUL F. RUSSELL

Of the International Health Division of the Rockefeller Foundation

and

#### FRANCISCO E. BAISAS

Of the Malaria Control Section of the Philippine Bureau of Health, Manila

#### FIVE PLATES

#### INTRODUCTION

The first reference relating to preferential breeding places of Philippine Anopheles appears to be that of Crosby(1) and Whitmore(2) as reported by Russell.(3) Other reports have come from Ludlow,(4) Banks,(5) Barber et al.,(6) Tiedemann,(7) Mieldazis,(8) Manalang,(9) Ejercito,(10) Baisas,(11) Holt and Russell,(12) King,(13) and Russell.(14)

These papers, of course, have been considered in preparing the article which we are presenting, but our report is based essentially on the collections of the staff of Malaria Investigations during the period from January, 1930, to September, 1934. (12, 14) These collections have been made in every province in the Philippine Islands, at various seasons, in all types of breeding places and at various altitudes. They form an excellent basis for conclusions regarding the selective breeding habits of local

¹ This paper is based on collections of Malaria Investigations, a project jointly supported by the Bureau of Science, Manila, and the International Health Division of the Rockefeller Foundation. We have had the assistance of Messrs. A. M. Nono and D. Santiago, of Malaria Investigations, in making many of our collections. The United States Army Medical Department Research Board collaborated in a number of field trips.

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anopheline larvæ. This paper is presented in conjunction with our practical key to the *Anopheles* larvæ of the Islands. (15)

#### GENERAL DISCUSSION OF ANOPHELES BREEDING PLACES

It is difficult to classify the breeding places of anopheline mosquitoes, because although many species show preferential breeding habits yet different species grow in association and the same species vary widely. Furthermore, there is at present little information available to indicate why local species are found in their usual habitats or why in unusual places.

The following list presents the chief types of breeding places in the Philippines.

- A. Running water.—Creek, stream, and river margins. Flowing ditches, canals, and springs. These breeding places may be shaded or open, clear or muddy, and the water may be moving very slowly or at moderate velocity.
- B. Stagnant fresh water.—Lakes, ponds, and grassy pools. Stagnant ditches and waste water. Fresh-water swamps and backwaters. Irrigation or artesian-well water from overflows or leaks. Residual river pools. Wells, cisterns, and artificial ponds.
- C. Small collections of fresh water.—Tree holes, cut stumps, and collections among roots of trees. Pools in rocks. Temporary rain puddles, hoof and wheel tracks. Miscellaneous barrels, tubs, etc.
- D. Rice fields.—The fields may be in cultivation or fallow. The water may be stagnant or have a perceptible current.
- E. Salt water.—Salt beds, fishponds, and lagoons. Brackish swamps and river mouths.

#### BREEDING PLACES OF PHILIPPINE ANOPHELES

The breeding places of Philippine *Anopheles* will be considered species by species.

- 1. Anopheles aitheni var. bengalensis.—Collected in Luzon, Mindanao, and Palawan. Breeds mainly in clear, cool, forest streams, along shaded edges where there is little or no current. It is not a common species, and even where found it is generally taken in small numbers.
- 2. Anopheles baezai (variety?).—Collected in Mindanao, Cagayan de Sulu, Capiz, Camarines Norte, and Palawan. Breeds only in pools of brackish water, shaded or exposed, with or without vegetation. This species is neither common nor abundant. It is sometimes associated with A. litoralis and A. subpictus

var. indefinitus. (We are not certain that this is true baezai, although the larvæ are identical with published descriptions. It is not typical umbrosus as previously reported in Philippine collections.)

- 3. Anopheles barbirostris.—Collected throughout the entire Archipelago, breeding abundantly in a wide variety of habitats, but not in salt water. It is found among aquatic vegetation and along the quiet edges of streams and rivers, both in the lowlands and mountains, in both shaded and exposed locations. It is abundant in large vegetated ponds and pools formed by springs or by dams, and it is equally prevalent in canals and irrigation ditches.
- 4. Anopheles filipinæ.—Collected in Luzon from Ilocos to Bicol regions. Also in Mindoro, Mindanao, and Masbate, but not reported from other islands. Neither very abundant nor very common. Most frequently breeds among aquatic plants in spring water, either slowly flowing or impounded. Sometimes taken in small numbers with A. minimus var. flavirostris along the banks of small streams, canals, or flowing ditches.
- 5. Anopheles annularis.—Widespread in Luzon, also reported from Misamis. Breeds among aquatic vegetation in large ponds of fresh water, also in slowly flowing ditches and in rice fields. Found also along shallow vegetated edges of lakes. Often associated with A. philippinensis, and sometimes with other species.
- 6. Anopheles gigas var. formosus.—Found in Mountain Province, Luzon, at elevations up to about 7,500 feet, breeding in heavily shaded streams, along the edges or among débris and aquatic plants. Found less abundantly in open grassy streams or canals. Often taken with A. lindesayi var. benguetensis.
- 7. Anopheles hyrcanus var. nigerrimus.—Collected from Luzon to Mindanao in rice fields, stagnant vegetated canals, and in impounded water. Not usually associated with sinensis but, on the contrary, usually taken where sinensis is scarce.
- 8. Anopheles hyrcanus var. sinensis.—Collected chiefly from Luzon, usually among aquatic vegetation in impounded spring water. Also in slowly flowing vegetated canals and ponds, and along the shallow edges of lakes, not infrequently associated with algæ and *Chara*. One of the few lowland species also found in the mountains, for example, at Baguio (5,000 feet).
- 9. Anopheles insulæflorum.—Found from Luzon to Mindanao, usually in quiet, shaded, forest streams, often among débris in small nooks where the water is not flowing. Sometimes found in the same stream as A. minimus var. flavirostris but usually

- not exactly in the same location. Anopheles insulæflorum seems to prefer parts of the stream bank where the water is more nearly stagnant.
- 10. Anopheles karwari.—Collected from Tayabas, Bulacan, and Laguna. Also from Bukidnon. A rare species in the Philippines. Found in spring pools and occasionally in clear shaded streams with A. maculatus.
- 11. Anopheles kochi.—Found from Luzon to Mindanao but not very abundantly. Breeds usually in small, muddy, open pools, during the rainy season. Also found in unplanted rice fields. Usually associated with A. vagus var. limosus.
- 12. Anopheles kolambuganensis.—Found only in a few localities in Mindanao, never abundantly. Breeds in streams within virgin forest, disappearing when the trees are cut and the streams cleared. Usually prefers quiet shaded portions of a stream where there is no direct current. Larvæ are often plainly seen by the collector with unaided eyes, because the white bands on the larvæ stand out in contrast to the dark background of water or débris.
- 13. Anopheles leucosphyrus.—Found in Luzon and Mindanao but not commonly or abundantly; in fact, this is a rare local species. Breeds in rock holes and stagnant pools in the beds of mountain creeks, in heavily shaded places.
- 14. Anopheles lindesayi var. benguetensis.—Reported from Luzon, in mountain streams of Baguio and Nueva Ecija and Laguna Provinces. Breeds in well-shaded streams among débris where it is usually easily seen because of the white markings of its body.
- 15. Anopheles literalis.—A common and abundant species along the coast of the entire Archipelago. Breeds only in salt or brackish water, in fishponds, salt beds, marshes, and stagnant pools, especially in the midst of algæ.
- 16. Anopheles ludlowi.—Found from Luzon to Mindanao in fresh-water rivers and streams. Breeds along the edges of streams, open or shaded, especially where the streams widen and stagnate. Most abundant from December to February. May be associated with A. subpictus var. indefinitus and A. maculatus.
- 17. Anopheles maculatus.—This species is sometimes a carrier of malaria. Found from Luzon to Mindanao, from low-lands to mountains, even up to 5,000 feet, but not abundantly. Most frequently found among algae at the edges of shaded forest streams. Sometimes associated with A. ludlowi and A. subpictus var. indefinitus.

- 18 Anopheles mangyanus.—Found from Luzon to Mindanao. Breeds in shallow flowing streams with sandy or rocky beds. Prefers clear water, either shaded or exposed. Grows among roots or grasses at the edges of streams, and sometimes in vegetated irrigation ditches. Not found above 2,000 feet. Frequently associated with A. minimus var. flavirostris.
- 19. Anopheles minimus var. flavirostris.—This species, the chief malaria vector in the Islands, is both common and abundant. We have collected this species in every province in the Philippines excepting Manila, Capiz, Iloilo, Romblon, and Surigao. However, it certainly occurs in every province but Manila. This species breeds particularly in foothill streams along the shaded edges, especially among bamboo roots. It is also sometimes found at the edges of rivers, canals, and irrigation ditches. It has been found in wells and is occasionally taken from stagnant pools where presumably it has been carried by an overflow from its natural breeding place. We have never found it in salt water or in rice fields. We have noticed no essential differences in the breeding habits of this anopheline from Ilocos Norte to Tawitawi and from Samar to Balabac. We have not found it above 2,000 feet altitude.
- 20. Anopheles parangensis.—Found only in Mindanao, as a very rare species. Usually in fresh-water pools formed in the deeper parts or side pools of a drying stream, usually well shaded with abundant vegetation. Occasionally associated with A. subpictus var. indefinitus and A. pseudobarbirostris. In recent collecting trips to northern Mindanao and to Cotabato made specially to obtain parangensis, we failed to find a single specimen. In 1933 our collection was extremely meager.
- 21. Anopheles philippinensis.—Found from Luzon to Mindanao, breeding usually in slews (backwaters), large ponds, and impounded water with Chara, Pistia, and other aquatic vegetation. Also found in rice fields and stagnated canals and ditches where there is abundant vegetation, and along the vegetated edges of lakes. Often associated with A. annularis, A. subpictus var. indefinitus, A. hyrcanus var. sinensis, and A. pseudobarbirostris.
- 22. Anopheles pseudobarbirostris.—Found from Luzon to Mindanao. Usually breeds in impounded water and large, well-vegetated ponds. Also found in ditches, canals, rice fields, and lakes, often associated with A. barbirostris, A. hyrcanus var. sinensis, and A. philippinensis.

- 23. Anopheles subpictus var. indefinitus.—Found from Luzon to Mindanao. This is the only Philippine species that breeds abundantly in both fresh and salt water. It is collected in slews, impounded water, stagnant parts of rivers, especially where Chara, algæ, and Pistia abound. Breeds abundantly in salt beds and fishponds, especially during and soon after the rainy season when the salinity of these places is not high.
- 24. Anopheles tessellatus.—Found in Luzon, Palawan, and Mindanao, neither abundantly nor commonly. Breeds in rice-field pools, also along the banks of streams among aquatic plants, and in small, heavily vegetated pools of spring water. Sometimes associated with A. maculatus, A. hyrcanus var. sinensis, and other stream-breeding species. Found both in lowlands and mountains.
- 25. Anopheles vagus var. limosus.—Found abundantly and commonly from Luzon to Mindanao, breeding mostly during and soon after the rainy season in small, open, muddy pools, newly plowed rice fields, and muddy, slow-flowing ditches. Often associated with A. kochi.
- 26. Balabac species or variety (?).—Found in Balabac and Iwahig, Palawan. Breeds in fresh-water pools, sometimes in the bed of a drying rocky stream. Water well shaded by forest trees, and containing decaying leaves and débris. Associated with A. barbirostris and A. kochi.
- 27. Near-leucosphyrus species or variety (?).—Found only in Mindanao. Breeds in rock holes in the beds of streams. These rock holes vary in diameter from a few inches to several feet. Green algæ are sometimes present where these larvæ are found. Holes well shaded; larvæ scarce and hard to collect. This species is found chiefly in the rainy season. True leucosphyrus may be found along the same stream but has not been taken with this "near-leucosphyrus" from the same holes.

#### SUMMARY

This paper summarizes what is known about the habitats of Philippine Anopheles larvæ. It is based on collections made by the staff of Malaria Investigations from January, 1930, to September, 1934, in every province in the Philippines under varying conditions as to altitude, type of breeding place, and time of year. In preparing this paper due attention has been paid to the published reports of others. It must be emphasized that the Philippine fauna is very rich in Anopheles mosquitoes and that relatively little is known about these important insects.

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# **ILLUSTRATIONS**

#### PLATE 1

- FIG. 1. Breeding place of Anopheles gigas var. formosus and A. lindesayi var. benguetensis. A stream southeast of Baguio Country Club, Mountain Province, Luzon. Elevation about 4,500 feet.
  - Breeding place of Anopheles aitkeni var. bengalensis, A. barbirostris, A. maculatus, and A. mangyanus (but not A. minimus var. flavirostris). Camp Labi, Nueva Ecija Province, Luzon. Elevation about 1,000 feet.
  - Breeding place of Anopheles barbirostris, A. leucosphyrus, and A. minimus var. flavirostris. Stream at Agricultural College, Laguna Province, Luzon. Elevation about 500 feet.

#### PLATE 2

- Fig. 1. Breeding place of Anopheles literalis. A salt-water lagoon on Langil Island, Zamboanga,
  - Breeding place of Anopheles hyrcanus var. sinensis, A. vagus var. limosus, and A. kochi. Rice field near Calauan, Laguna Province, Luzon.
  - 3. Breeding place of Anopheles tessellatus, A. barbirostris, A. pseudo-barbirostris, A. philippinensis, A. annularis, A. hyrcanus var. nigerrimus, and A. hyrcanus var. sinensis. A sluggish canal near Calauan, Laguna Province, Luzon.

#### PLATE 3

- Fig. 1. Breeding place of Anopheles filipinæ, A. barbirostris, A. pseudobarbirostris, A. hyrcanus var. sinensis, and A. subpictus var. indefinitus. Impounded spring water (tanque), Calauan, Laguna.
  - Breeding place of Anopheles literalis and A. subpictus var. indefinitus. Salt-water fishpond, Parañaque, Rizal Province, Luzon.
  - Breeding place of Anopheles ludlowi, A. subpictus var. indefinitus, and A. vagus var. limosus. Marikina River, Marikina, Rizal Province, Luzon.

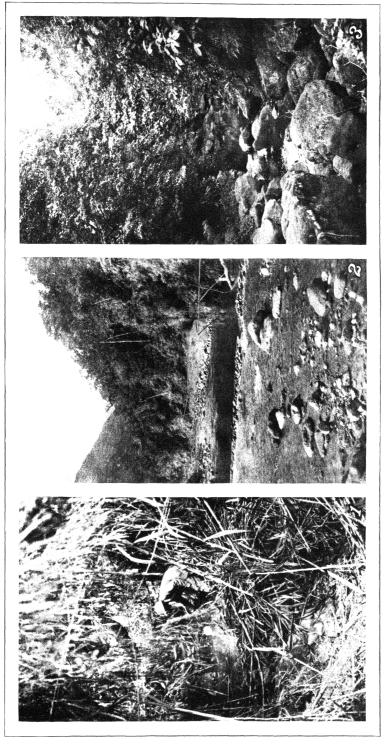
#### PLATE 4

- Fig. 1. Breeding place of Anopheles minimus var. flavirostris. Calauan, Laguna Province, Luzon.
  - Breeding place of Anopheles subpictus var. indefinitus but not of A. litoralis. Brackish-water fishpond, Parañaque, Rizal Province, Luzon.
  - Breeding place of Anopheles baezai(?). Iwahig Penal Colony, Palawan.

#### PLATE 5

- Fig. 1. Breeding place of Anopheles kochi and A. vagus var. limosus. Rain puddle, Calauan, Laguna Province, Luzon.
  - 2. Breeding place of Anopheles minimus var. flavirostris. A spring in Iwahig, Palawan. (Foreground with ladder. The stream in the background is also a breeding place of A. minimus var. flavirostris.)

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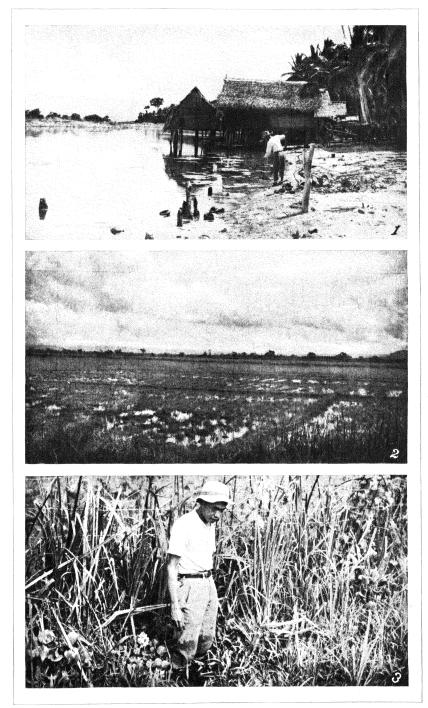


PLATE 2.

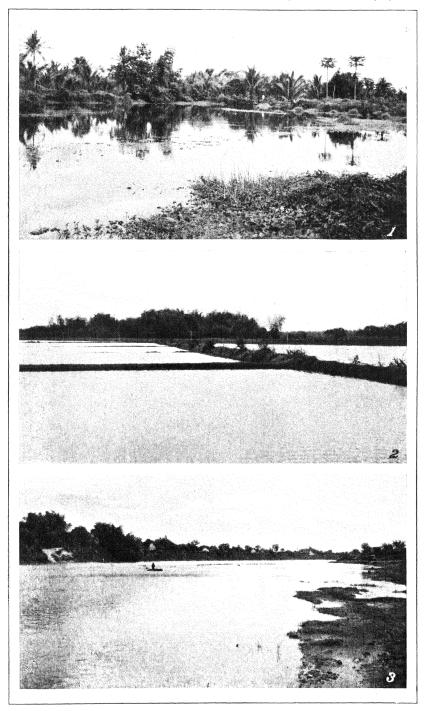
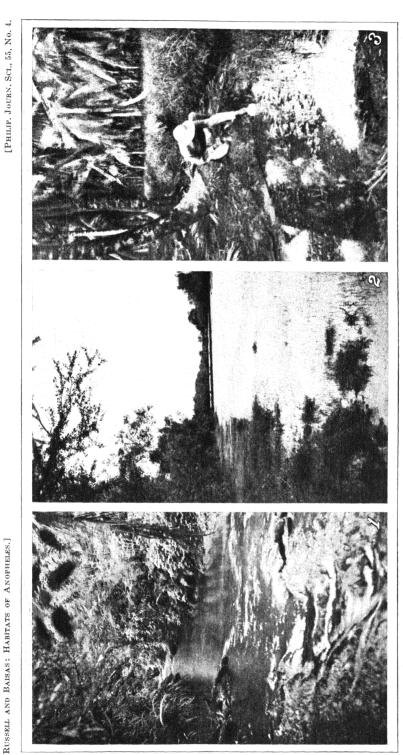


PLATE 3.



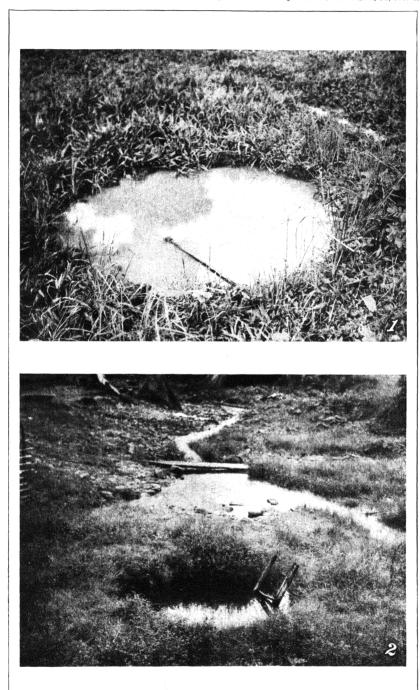


PLATE 5.

# A PRACTICAL ILLUSTRATED KEY TO LARVÆ OF PHILIPPINE ANOPHELES <sup>1</sup>

#### By PAUL F. RUSSELL

Of the International Health Division of the Rockefeller Foundation

and

#### FRANCISCO E. BAISAS

Of the Malaria Control Section of the Philippine Bureau of Health
Manila

#### INTRODUCTION

#### THIRTY-THREE PLATES AND FIVE TEXT FIGURES

There has long been needed a practical illustrated key to the larvæ of Philippine anopheline mosquitoes. The one presented in this paper has been prepared by the authors during 1934, making use of the collections of the field staff of Malaria Investigations. It is original in that every drawing is a new one, made under the direct supervision of the authors and in that the key has been prepared recently in our laboratory.

Naturally our key is based on the work of many authors who have studied *Anopheles* larvæ common to the Philippines. The work of Ludlow, (1) Banks, (2) Mieldazis, (3) Manalang, (4)

¹ The senior author is chief of Malaria Investigations which is jointly supported by the Bureau of Science, Manila, and the International Health Division of the Rockefeller Foundation. The junior author has been detailed to Malaria Investigations by courtesy of Dr. J. Fajardo, director of the Philippine Bureau of Health. We are indebted to the following for assistance at various times during the year in which we have been preparing this paper: Messrs. Andres M. Nono and Domingo Santiago, Miss Amparo Capistrano, and Mrs. Isabel V. Ramos, all of the staff of Malaria Investigations. All of the drawings are original and were prepared from larvæ caught by the staff of Malaria Investigations. The artists were Miss Lourdes Moskaira (deceased) and Mr. Eliseo Enriquez, to whom we are indebted for painstaking efforts. We would also acknowledge gratefully the assistance of the photographic department of the Bureau of Science.

Baisas, (5) and King (6) has been of importance in developing our knowledge of the Philippine Anopheles. The papers by Puri (7) and the recent text by Christophers (8) have been invaluable, The latter gives numerous important references. So too the works of Martini (9) and Root (10) are very useful. Russell (11) gives a complete bibliography of Philippine references.

Our key, of course, is subject to revision and it is not presented as a research study in entomology. In its present form it seems to meet present needs and it has been prepared for practical use.

#### LARVAL CHARACTERS

Anopheles larvæ possess characteristic hairs which are fairly uniform in fourth-stage specimens. Only larvæ in this last stage, or instar, have been considered in this key. It is not feasible to discuss these characters at length in this paper. Those interested will find good descriptions in Puri(7) and Christophers. (8) We shall merely briefly describe and tabulate below those characters which we have used in our own key.

The hair numbers refer to the numbers assigned to individual hairs by Puri, (7) Martini, (9) and Root. (10) There is a separate series of consecutive numbers for the hairs of each of the following parts of a larva—the head, the prothorax, the mesothorax, the metathorax, and each segment of the abdomen. Dorsal hairs come first and then ventral in the same series (see text figs. 1 to 4).

# A. HEAD (TEXT FIG. 1)

- 1. Clypeal hairs.—These hairs arise on the front of the fronsclypeus. They are as follows:
  - i. c. Inner clypeal or inner anterior clypeal (hair 2).
  - o. c. Outer clypeal or outer anterior clypeal (hair 3).
  - p. c. Posterior clypeal (hair 4).

In the subgenus Anopheles the bases of the inner clypeal hairs are closely approximated, often nearly touching. In the subgenus Myzomyia these inner clypeals are widely separated, usually twice or more than twice the distance between the bases of the inner and outer hair of the same side.

- 2. Occipital hairs.—Those we have used are the following:
- i. o. Inner occipital or sutural (hair 8).
- o. o. Outer occipital or trans-sutural (hair 9).

These hairs are frequently as long as the posterior clypeal. The inner hair is usually simple but may be branched. The outer hair may be simple or feathered.

3. Antennal or shaft hair (hair 11).

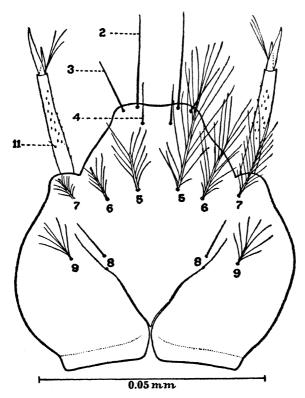


Fig. 1. Head of larva, showing hairs; semidiagrammatic.

#### B. THORAX (TEXT FIGS. 2 AND 3)

# 1. Prothoracic hairs.—Those used are the following:

- i. s. p. Inner anterior submedian prothoracic or inner submedian prothoracic (hair 11).
- m. s. p. Middle anterior submedian prothoracic or middle submedian prothoracic (hair 2).

These, with an outer hair 3, comprise the so-called "shoulder hairs." Usually the middle one is largest and is stout and feathered. The inner hair is sometimes simple but may be branched or feathered.

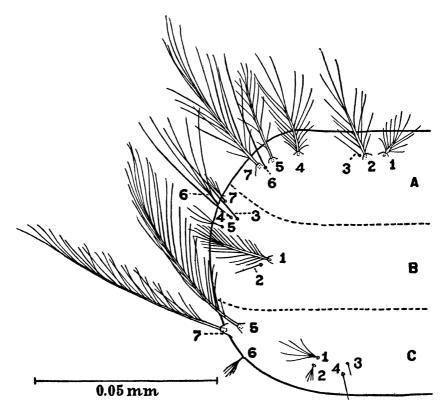


Fig. 2. Dorsum of thorax, showing hairs; semidiagrammatic.

p. v. s. m. Prothoracic ventral submedian or prothoracic (hair 13).

p. t. p. Prothoracic pleural hair group, (hairs 9 to 12).

These pleural hairs are important. They are on the ventrolateral surface of each segment of the thorax and all four in each group arise from a common base. These hairs may be simple or feathered in different combinations. They are useful in separating subgenera.

2. Mesothoracic hairs.—Those used are the following:

m. t. 5. Mesothoracic hair 5. This is one of the small dorsolateral hairs (see text fig. 2).

m. t. p. Mesothoracic pleural hair group (hairs 9 to 12 of Puri and in our text fig. 3, but numbered 10 to 13 by Martini and Root).

# 3. Metathoracic hairs.—Those used are the following:

m. v. s. m. Metathoracic ventral submedian or metathoracic hair 18. t. p. Thoracic palmate (hair 1 of Puri and our text fig. 2, but 4 of Martini and Root).

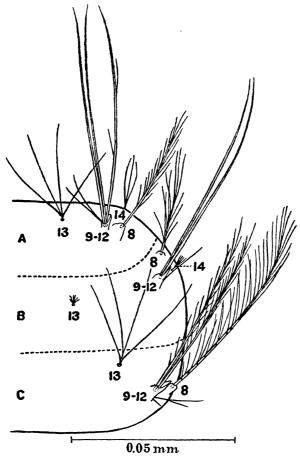


Fig. 3. Venter of thorax, showing hairs; semidiagrammatic.

This thoracic palmate may be simple or have unflattened branches, in which case it is called undeveloped or rudimentary. Frequently it has flattened branches arising together, in which case it is somewhat like an abdominal palmate although never so well developed.

#### C. ABDOMEN (TEXT FIG. 4)

Abd. pal. Abdominal palmate hairs (or float hairs) on segments I to VII (hair 1).

This hair may be poorly developed, especially on segments I and II. It is developed when it has flattened branches which arise in a whorl from a common base. Well-developed palmate hairs have leaflets which may or may not be serrated or notched and the end portion of which may or may not be in the form of a filament.

a. pal. Antepalmate or prepalmate (hair 2). This hair is posterior to the palmate on segment VI.

d.-l. p. Dorsolateral posterior (hair 5).

lat. Lateral (hairs 6 and 7).

ter. pl. Tergal plates (anterior).

These oval chitinous plates are seen near the anterior border of each abdominal segment. They may be large or small. There are also posterior plates but they are very small. The tergal plates referred to in our own key are the anterior plates. In judging the size of tergal plates refer to those of segments III to VI. The VIIth has a comparatively large plate in all species, and in many species this is also true of the first.

Large: Covers about two-thirds of the width and about one-third of the length of the segment.

Small: Covers at most (usually much less) about one-fifth of the segment either way.

In whole and living specimens an easier way to determine the size of the tergal plate is:

Large: Lateral ends extend far beyond the mid-dark area covered by the alimentary tract and trachial tubes.

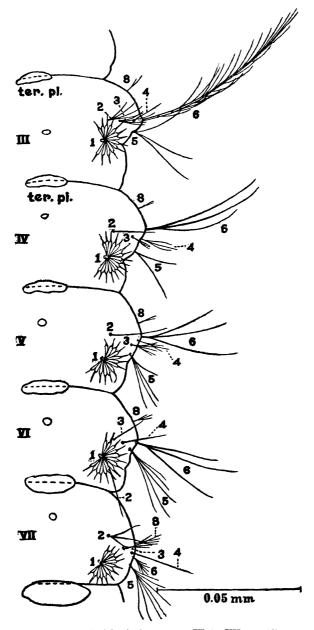
Small: Lateral edges barely reach or extend only a little beyond the dark area covered by the alimentary tract and trachial tubes.

pect. Pecten or comb.

The pecten, or comb, is one of the structures around the spiracles. It has long and short projections referred to as teeth.

stig. club. Stigmal club.

We have used this term for the much enlarged chitinous peg lying between the spiracular openings in pseudobarbirostris.



Frg. 4. Dorsal view of abdominal segments III to VII; semidiagrammatic. 286780——2

It is illustrated in Plate 13 and text fig. 5. For further description see Christophers. (12) What we call stigmal club is referred to by him as "a dense chitinized apex or point anteriorly (of median plate) which lies between the spiracular openings." Imms (13) calls this stigmal club the "chitinous peg" and describes it as "a stout hollow peg of very dark chitin which projects beneath the integument slightly into the cavity of the animal." He notes that the transverse and median plates of the skeleton are attached to this peg. Apparently all Anopheles

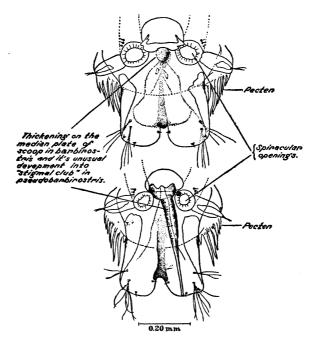


FIG. 5. Spiracular apparatus: A. barbirostris and A. pseudobarbirostris.

larvæ have this chitinous peg but in *pseudobarbirostris* it is so extraordinarily well developed and prominent that we have referred to it as "stigmal club," present in *pseudobarbirostris* but absent in other species, although as noted above there is a small chitinous peg present in all *Anopheles* larvæ.

In the branching of larval hairs there are, of course, irregularities. This is true of the pilotaxy of *Anopheles* larvæ in other parts of the world. Therefore, one should occasionally expect to see hairs branched which usually are simple and vice versa. Even duplication of hairs is sometimes seen.

In some species the branching of the inner clypeal hairs is so fine that it can be detected only with relatively high magnification. The number of branches is not always the same but we have presented average numbers which should be fair guides. However, sometimes only the stump of a branch remains, the branch itself having been broken off. In such cases considerable care is required to determine the correct branching of the hair in question. The following practical definitions may be of use:

anterior. Towards the head of larva.

posterior. Towards the tail of larva.

ventral. The underside of larva.

dorsal. The top side of larva. This upper side may be recognized by the palmate hairs, or their representatives, on the body and by the occipital hairs on the head.

apical. Towards the outer end of a hair.

basal. Towards the inner end or origin of a hair.

closely approximated and widely separated. The clypeal hairs are closely approximated if their bases are so close that there is scarcely room for another base between them. If more than one base can be put between them they are called widely separated. By another criterion these hairs are closely approximated if the distance between their bases is much less than the distance between the inner and outer clypeal hairs on one side.

dichotomous. Dividing regularly into pairs.

plumose. Resembling a feather.

feathery. With branches coming off the main stem like the branches of a feather, not in pairs.

instar. Stage of development of larva.

serrated. With teethlike irregularities. Notched like a saw.

rachis. Main stem or shaft.

filamented. Having a threadlike prolongation.

confluent. Not distinctly separated but running together almost or quite like one structure.

The notes which follow are not exhaustive but are intended to be of practical assistance in the use of our key.

#### SYNOPTIC TABLE OF PHILIPPINE ANOPHELES

The following classification of Philippine Anopheles is based largely on Christophers. (8) Following him, the local species may be classified as follows:

# A. Tribe ANOPHELINI.

Genus I. Chagasia (none in the Philippine Islands).

Genus II. Bironella (none in the Philippine Islands).

Genus III. Anopheles.

#### B. Genus ANOPHELES.

Subgenus I. Stethomyia (none in the Philippine Islands).

Subgenus II. Anopheles.

Subgenus III. Nyssorhynchus (none in the Philippine Islands).

Subgenus IV. Myzomyia.

#### C. Subgenus ANOPHELES.

Group I. Anopheles.

Group II. Arribalzagia (none in the Philippine Islands).

Group III. Christya (none in the Philippine Islands).

#### D. Group ANOPHELES.

Series I. Anopheles.

- 1. Anopheles aitkeni var. bengalensis.
- 2. Anopheles gigas var. formosus.
- 3. Anopheles insulæflorum.
- 4. Anopheles lindesayi var. benguetensis.

Series II. Lophoscelomyia (none in the Philippine Islands).

Series III. Myzorhynchus.

- 5. Anopheles baezai (variety?).
- 6. Anopheles barbirostris.
- 7. Anopheles hyrcanus var. nigerrimus.
- 8. Anopheles hyrcanus var. sinensis.
- 9. Anopheles pseudobarbirostris.

#### E. Subgenus MYZOMYIA.

Group I. Neomyzomyia.

Group II. Myzomyia.

Group III. Pseudomyzomyja.

Group IV. Paramyzomyia (none in the Philippine Islands).

Group V. Neocellia.

Group VI. Cellia (none in the Philippine Islands).

#### F. Group NEOMYZOMYIA.

- 10. Anopheles kochi.
- 11. Anopheles kolambuganensis (not included by Christophers).
- 12. Anopheles leucosphyrus.
- 13. Anopheles tessellatus.

#### G. Group MYZOMYIA.

- 14. Anopheles filipinæ.
- 15. Anopheles mangyanus.
- 16. Anopheles minimus var. flavirostris.

#### H. Group PSEUDOMYZOMYIA.

- 17. Anopheles litoralis.
- 18. Anopheles ludlowi.
- 19. Anopheles parangensis.
- 20. Anopheles subpictus var. indefinitus.
- 21. Anopheles vagus var. limosus.

- I. Group NEOCELLIA.
  - 22. Anopheles annularis (fuliginosus).
  - 23. Anopheles karwari.
  - 24. Anopheles maculatus.
  - 25. Anopheles philippinensis.

The list of Philippine anophelines is provisional. Several species are still under scrutiny by King and also by Baisas. The table is the best we can prepare at present.

#### A. Subgenus ANOPHELES

- I. Group ANOPHELES Series ANOPHELES
- 1. ANOPHELES AITKENI var. BENGALENSIS Puri, 1930.

Stethomyia pallida Ludlow, 1905, belongs either to this variety or to A. insulæflorum. Only a single female was described.

- A. X-2 of Baisas, 1927.
- 2. ANOPHELES GIGAS var. FORMOSUS Ludlow, 1909.
- 3. ANOPHELES INSULÆFLORUM Swellengrebel and Swellengrebel de Graaf, 1920.

Stethomyia aitkeni var. insulæflorum of Swellengrebel, 1920.

- A. X-3 of Baisas, 1927.
- 4. ANOPHELES LINDESAYI var. BENGUETENSIS King, 1931.
  - II. Group ANOPHELES Series MYZORHYNCHUS
- 5. ANOPHELES BAEZAI Gater, 1933. (?).
  - A. umbrosus Theobald of Mieldazis, 1930, and other Philippine
  - A. umbrosus var. separatus Leicester of Philippine authors.

We are not certain that our form is true baezai. It may be what Gater calls "form A." It is certainly not typical umbrosus.

- 6. ANOPHELES BARBIROSTRIS Van der Wulp, 1884.
  - ? vanus Walker, 1860.

Myzorhynchus vanus of Ludlow, 1908.

A. barbirostris varieties 1 and 2 (in part) of Baisas, 1927.

Some larvæ, collected in 1933 by Malaria Investigations in Palawan, may be a new variety of *barbirostris*. They show much less branching of the clypeal hairs.

- 7. ANOPHELES HYRCANUS var. NIGERRIMUS Giles, 1900.
  - ? nero Doleschall, 1851.
  - A. indiensis Theobald, 1901.
  - ? pursati Laveran, 1902.

Anopheles II of Schüffner, 1902 (probably).

A. bentleyi Bentley, 1902.

Myzorhynchus minutus Theobald, 1903.

Myzorhynchus argyropus Swellengrebel, 1914.

Myzorhynchus peditaeniatus Leicester, 1908, of Walker and Barber, 1914 (in part).

#### 8. ANOPHELES HYRCANUS var. SINENSIS Wiedemann, 1828.

A. plumiger Dönitz, 1901.

A. jeosoensis Tsuzuki, 1902 (A. vesoensis 1901).

Myzorhynchus peditaeniatus Leicester, 1908, of Walker and Barber, 1914 (in part).

A. hyrcanus varieties 1 and 2, Baisas, 1929 (in part).

A. sinensis of Philippine authors.

#### 9. ANOPHELES PSEUDOBARBIROSTRIS Ludlow. 1902.

A. barbirostris var. No. 1, Baisas, 1927 (in part).

A variety intermediate between barbirostris and hyrcanus, Baisas, 1927.

#### B. Subgenus MYZOMYIA

#### I. Group NEOMYZOMYIA

#### 10. ANOPHELES KOCHI Dönitz, 1901.

A. ocellatus Theobald, 1901.

A. Ia of Schüffner, 1902.

Cellia flava Ludlow, 1908.

Christophersia halli James, 1910.

N. tessellata of Mathis and Leger, 1910.

#### 11. ANOPHELES KOLAMBUGANENSIS Baisas, 1931.

Unnamed species of Manalang, 1929.

A. kolambuganensis, Manalang MSS (Baisas, 1931).

#### 12. ANOPHELES LEUCOSPHYRUS Dönitz, 1901.

Myzomyia ? elegans James, 1903.

(Note: The leucosphyrus of Luzon, those of Mindanao, and the Balabac forms, may be geographic variants of one species. The "near-leucosphyrus" of Mindanao appears to be a distinct species.)

## 13. ANOPHELES TESSELLATUS Theobald, 1901.

A. deceptor Dönitz, 1902.

Myzomyia thorntonii Ludlow, 1904.

Dactylomyia ceylonica Newstead and Carter, 1910.

A. punctulatus of James and Liston, 1910.

A. X-6 of Baisas, 1927.

#### II. Group MYZOMYIA

#### 14. ANOPHELES FILIPINÆ Manalang, 1930 (Christophers and Puri, 1931).

A. minimus varieties 1, 2, and 3 of Baisas, 1927.

A. aconitus var. filipinæ Manalang, 1930.

A. "minimus variety" of Philippine authors.

#### 15. ANOPHELES MANGYANUS Banks, 1907.

Perhaps Myzomyia funesta of Whitmore, 1904, in part.

? Pyretophorus pitchfordi Giles, 1904.

Myzomyia mangyana Banks, 1907.

A. christophersi Edwards (in part, not Theobald) 1914.

Myzomyia febrifera Banks, 1914.

Anopheles febrifer Walker and Barber, 1914 (perhaps in part).

Anopheles (Myzomyia) christophersia Ludlow (in part, not Theobald), 1915.

A. minimus Christophers (in part, not Theobald), 1916.

Probably A. minimus and A. funestus (in part) and possibly A. aconitus var. filipinæ (in part) of Philippine authors.

#### 16. ANOPHELES MINIMUS var. FLAVIROSTRIS Ludlow, 1914 (King. 1932).

Pyretophorus minimus Giles (not Theobald) 1904.

Myzomyia funesta of Whitmore (in part), 1904.

Myzomyia funesta Ludlow (not Giles) 1905 to 1914 (in part).

Very likely A. febrifer of Walker and Barber (1914) was in large part this species.

Myzomyia flavirostris Ludlow 1914.

A. christophersi Edwards (in part, not Theobald), 1914.

Anopheles christophersi Ludlow (in part, not Theobald), 1915.

A. minimus Edwards (not Theobald), 1915.

A. minimus var. aconitus Christophers (not Dönitz), 1916.

A. (Myzomyia) minimus Christophers (in part, not Theobald), 1924.

A. minima var. flavirostris Yamada, 1925.

A. minimus Baisas, 1927 (description of larva).

A. funestus Manalang (in part, not Giles), 1930, et seq.

#### III. Group PSEUDOMYZOMYIA

#### 17. ANOPHELES LITORALIS King, 1932.

Myzomyia ludlowi Theobald 1903 in part as used by Philippine authors.

A. sundaicus of Rodenwaldt, 1926 (in part perhaps).

This is the "salt-water" A. ludlowi of Philippine authors.

#### 18. ANOPHELES LUDLOWI Theobald, 1903.

Myzomyia ludlowi Theobald, 1903.

M. vaga of Schüffner and Swellengrebel, 1917.

A. hatorii of Koidzumi, 1923 (in part perhaps).

A. (Myzomyia) ludlowi var. flavescens of Swellengrebel, 1921.

This is the "fresh-water" A. ludlowi of Philippine authors.

#### 19. ANOPHELES PARANGENSIS Ludlow, 1914.

M. ludlowi variety of Ludlow, 1914.

Myzomyia parangensis Ludlow, 1914.

#### 20. ANOPHELES SUBPICTUS var. INDEFINITUS Ludlow. 1904.

A. formosaensis II (in part) Tsuzuki, 1902.

Myzomyia rossii Giles var. indefinita Ludlow, 1904.

A. subpictus Grassi of Tiedemann, 1927.

A. subpictus var. malayensis Hacker of Tiedemann (in part), 1927.

A. rossii (river-slew type) Baisas, 1927.

#### 21. ANOPHELES VAGUS var. LIMOSUS King, 1932.

- A. formosaensis II Tsuzuki (in part), 1902.
- A. subpictus var. malayensis (in part) of Tiedemann, 1927.
- A. rossii (pool type) Baisas, 1927.

- A. rossii Giles (in part) of Philippine authors.
- A. vagus of Philippine authors.

#### IV. Group NEOCELLIA

- 22. ANOPHELES ANNULARIS Van der Wulp, 1884.
  - A. fuliginosus Giles, 1900.
  - A. leucopus Dönitz, 1901.
  - A. jamesi Liston, 1901.
  - A. nagpori James and Liston, 1904.

Nyssorhynchus fuliginosus var. adiei James and Liston, 1911.

#### 28. ANOPHELES KARWARI James, 1903.

Nyssorhynchus karwari James, 1903.

A. nigrans Stanton, 1912.

#### 24. ANOPHELES MACULATUS Theobald, 1901.

- A. maculata Theobald, 1901.
- ? Nyssorhynchus theobaldi of Ludlow, 1901.

Nyssorhynchus pseudowillmori Theobald, 1910.

- A. maculatus var. dravidicus Christophers, 1924.
- A. hanabusai Yamada, 1925.

We have not run across an aberrant form of A. maculatus which, according to Christophers, 1931, resembles N. theobaldi in form. The few A. maculatus we have from Baguio (5,000 feet altitude) show, on the average, as much scaling on the dorsum of the abdomen of the adults as those from the lowlands of Luzon, but less than those from Mindanao. None, however, shows any maculation on the palps, while a few from the lowlands have this characteristic.

#### 25. ANOPHELES PHILIPPINENSIS Ludlow. 1902.

Nyssorhynchus nivipes Theobald, 1903.

A. pallidus (in part) Dyar and Shannon (not Theobald), 1925.

Pyretophorus freeræ Banks, 1906.

- A. pampangensis Brunetti, 1920.
- A. fuliginosus of Stanton, 1915.

#### C. Undetermined

#### 26. Balabac ANOPHELES of undetermined species or variety (?).

Some larvæ of a species or variety not yet reported in the Philippines were found in Balabac, Palawan, by P. F. Russell and Andres M. Nono. Similar larvæ have been found recently in Iwahig, Palawan. These are being studied and as soon as possible a report will be made. Possibly this anopheline is a variety of leucosphyrus.

#### 27. ANOPHELES near-LEUCOSPHYRUS (?).

Taken in Mindanao by F. E. Baisas and D. Santiago.

#### 28. ANOPHELES of undetermined variety (?).

A larva apparently belonging to the aitheni group but having the inner anterior clypeal with nine and ten main branches each (not the fine subbranches found in some bengalensis), was found on Mount Banahao by F. E. Baisas and D. Santiago.

#### DESCRIPTIVE NOTES

We have used the following abbreviations in our notes:

- i. c. Inner clypeal hairs.
- o. c. Outer clypeal hairs.
- p. c. Posterior clypeal hairs.
- i. o. Inner occipital hairs.
- o. o. Outer occipital hairs.
- i. s. p. Inner submedian prothoracic hairs.
- m. s. p. Middle submedian prothoracic hairs.
- sh. Shoulder hairs (i. s. p. and m. s. p. included).
- p. v. s. m. Prothoracic ventral submedian or prothoracic hair 13.
- p. t. p. Prothoracic pleural hair group.
- m. t. 5. Mesothoracic hair 5.
- m. t. p. Mesothoracic pleural hair group.
- m. t. v. s. m. Metathoracic ventral submedian or metathoracic hair 13.
- t. pal. Thoracic palmate.
- abd. pal. Abdominal palmate.
- a. pal. Ante- or prepalmate.
- lat. Lateral hairs.
- d.-1. p. Dorsolateral posterior (hair 5 on segment VI).
- ter. pl. Tergal plates.
- pect. teeth. Short and long teeth of pecten.
- stig. cl. Stigmal club.

Roman numerals refer to abdominal segments. Arabic numbers in the notes below refer to the numbers of branches or leaflets of a given hair.

 ANOPHELES AITKENI var. BENGALENSIS. Plate 2; Plate 29, figs. A and B; Plate 32, fig. 3; Plate 33, fig. 9.

A small dark larva; i. c. closely approximated, branched at about middle into 2 to 4 main branches with or without fine subbranches; o. c. 2 or 3 lateral branches (rarely simple); p. c. 4 to 6; i. o. 4 to 6; o. o. 5 to 9; i. s. p. 1 to 13; m. s. p. 9 to 15; t. pal. developed, with 13 to 18 leaflets; abd. pal. I developed but small, with 7 to 16 leaflets; abd. pal. II to VII well developed, with 12 to 20 leaflets; lat. III numerous branches, feathery; lat. IV and V 4 to 7.

The types of branching of the clypeal hairs which have been illustrated by Puri (7) and Gater (18) are also found in the Philippines. We found one specimen on Mount Banahao, at an elevation of about 3,000 feet, whose i. c. are branched 9 or 10. One of the o. c. has 7. (The other o. c. is missing.) At present we prefer to group our varieties under this one heading of aitheni var. bengalensis, although in the key we have noted the variety from Banahao.

#### 2. ANOPHELES GIGAS var. FORMOSUS. Plate 7.

Largest local anopheline larva. Light yellow to gray. Rarely has distinct white markings on body. I. c. closely approximated usually simple, sometimes 2 or 3; o. c. simple or 2 to 6 lateral branches; p. c. relatively long with 2 to 8; i. o. 4 to 12; o. o. 6 to 16; i. s. p. relatively small, 3 to 10; m. s. p. 8 to 15; t. pal. rudimentary; abd. pal. I and II rudimentary; abd. pal. III to VII with leaflets smoot or serrated, and unfilamented; lat. IV and V long, 2 to 5, usually 3 or 4; lat. VI very short.

#### 8. ANOPHELES INSULÆFLORUM. Plate 10; Plate 33, fig. 10.

A medium-sized larva, usually very black; i. c. closely approximated, simple; o. c. short, simple, sometimes forked; p. c. 3 to 6; i. o. 3 to 6; o. o. 4 to 10; sh. short and stout, the inner sometimes much like an elongated fan in shape, and usually 3 to 11 stout branches, rarely simple, middle hair 8 to 14; t. pal. developed; abd. pal. all developed.

#### 4. ANOPHELES LINDESAYI var. BENGUETENSIS. Plate 15; Plate 30, figs. C and D.

A larva of more than medium size, easily recognized by alternation of white and black markings on its body; white markings fairly well retained in formalin. (Some larvæ collected at Haight's Place at 7,500 feet have imperfect or no white markings.) I. c. closely approximated, long, simple, rarely forked; o. c. simple; p. c. 2 to 5, sometimes simple; i. o. usually simple, sometimes forked; o. o. 2 to 6 rarely simple; i. s. p. 10 to 16; m. s. p. 8 to 15; t. pal. developed; abd. pal. I rudimentary; abd. pal. II to VII developed, leaflets filamented; lat. IV and V 2 or 3; lat. VI very short.

#### 5. ANOPHELES BAEZAI (?) Plate 3; Plate 31, fig. 5.

A large brown to black larva, only the young forms have definite white markings; i. c. closely approximated, finely branched distally; o. c. dichotomously branched, less plumose than in any of the barbirostris-hyrcanus group; p. c. simple or forked; i. o. 2 to 5; o. o. 2 to 5; i. s. p. 3 to 6 apically; m. s. p. 6 to 10; t. pal. rudimentary, branched like ordinary hair with 4 to 6; abd. pal. no true palmates but instead there are ordinary hairs branched 7 to 15; lat. IV 7 to 12; lat. V 2 or 3, sometimes simple. One of the bladelike projections at the distal end of the antenna is not pointed but truncated and is notched at its tip. (Note: Certain adult characters indicate that this larva may be a variety and not true baezai.)

#### 6. ANOPHELES BARBIROSTRIS. Plate 4; Plate 30, fig. A.

One of largest larvæ, varying in color from dark brown to grayish yellow, with or without white markings of various patterns; i. c. closely approximated, simple, rarely forked; o. c. dichotomously branched, more than 20, plumose; p. c. usually branched; i. o. 5 to 16; o. o. 6 to 15; i. s. p. 4 to 15 near base; m. s. p. 9 to 19; t. pal. developed but not pigmented; abd. pal. all developed; I and II not pigmented; lat. VI very short; d.-l. p. present; stig. cl. absent.

A few specimens of "barbirostris" in our collection, from Iwahig, Palawan, have less than the usual branching of the outer clypeal hair and it is possible that a separation will have to be made between the larvæ having more than 20 branches—A. barbirostris—and those having less than 20 branches. The latter may be A. barbumbrosus Strickland and Choudhury, 1927, as described by Gater, 1934, but we do not have enough adults to make a definite pronouncement.

#### 7. ANOPHELES HYRCANUS var. NIGERRIMUS. Plate 8.

A large larva, like barbirostris, light yellow, yellow-red to dark brown; i. c. closely approximated, usually simple, sometimes 2 to 7; o. c. dichotomously branched, branches long, more than 10, plumose; p. c. 2 to 8 (rarely simple); i. o. 3 to 10; o. o. 2 to 8; i. s. p. single or apically branched 2 or 3; p. v. s. m. short stem, 4 or 5, branches not widely separated; m. t. 5 small, with slender curved branches 5 to 16, usually 6 to 8; m. t. v. s. m. 2 to 4, usually 3 (rarely simple); t. pal. well developed, not pigmented; abd. pal. well developed, I and II not pigmented; lat. IV and V 2 or 3 (rarely simple); lat. VI very short; d.-l. p. present; stig. cl. absent.

# 8. ANOPHELES HYRCANUS var. SINENSIS. Plate 9; Plate 32, fig. 8.

Somewhat smaller than *nigerrimus* but resembling it closely in coloration. This larva is similar to *nigerrimus* in most of its hairs, but presents the following differences:

P. v. s. m. a long stem with usually more than 5 branches. These branches are spread out, relatively far apart, along the main rachis. In *nigerrimus* the stem is short and the 4 or 5 branches originate close together near apex of main rachis. Rarely this hair in *sinensis* resembles that in *nigerrimus*.

M. t. 5 in *sinensis* is always stout, straight, and with straight branches 2 to 5, usually 3 or 4. In *nigerrimus* this hair is

shorter, slenderer, and with slender, curving branches, spread out in a starlike pattern.

M. t. v. s. m. simple or branched 2 to 4, usually 2; in nigerrimus the usual branching is 3.

In sinensis larvæ from Baguio (5,000 feet) the prothoracic hair 13 (p. v. s. m.) tends to have fewer branches than in low-land sinensis and it has a pattern intermediate between the usual sinensis and nigerrimus. Mesothoracic hair 5 (m. t. 5) gives an accurate index in having straight stout branches like the lowland sinensis, although there are usually 4 and sometimes 5 branches in the Baguio larvæ. The metathoracic hair 13 (m. v. s. m.) usually has 3 branches instead of 2, as in the lowland species.

#### 9. ANOPHELES PSEUDOBARBIROSTRIS. Plate 23; Plate 33, fig. 11.

One of the largest of local anopheline larvæ. Varies in color from black to light brown, with or without markings of indefinite pattern; i. c. finely branched at about apical third, closely approximated; o. c. dichotomously branched, plumose; p. c. short, simple, sometimes branched; i. o. 6 to 13; o. o. 2 to 11; i. s. p. simple or branched 2 to 4 at middle; m. s. p. 8 to 17; abd. pal. developed; lat. IV to VI all long and branched. (This is the only species of that group of local anopheline larvæ having closely approximated i. c. in which the lat. VI is long and well developed.) Stig. cl. present.

## 10. ANOPHELES KOCHI. Plate 12; Plate 33, fig. 3.

A medium-sized larva, light brown with a distinct white spot on the anterior half of thorax and another on tip of abdomen; i. c. finely branched, widely separated; o. c. simple; p. c. short, simple, occasionally forked; i. o. simple or forked; o. o. simple or forked, sometimes 3-branched; i. s. p. slender 5 to 12; m. s. p. 8 to 15; sh. slender stem and branches, tubercle small, not confluent; p. v. s. m. 3 to 6 slender branches; t. pal. developed, leaflets not well spread; abd. pal. I rudimentary; abd. pal. II developed, not pigmented; abd. pal. III-VII well developed and pigmented; lat. III up to 11 usually less than 10 branches; lat. IV to VI 2 to 3, sometimes single, IV and V more than half length of III; ter. pl. small.

## 11. ANOPHELES KOLAMBUGANENSIS. Plate 13.

A medium-sized larva easily recognized because of its very white and black markings, the white being sharply retained for some years in formalin or Gater's fluid; i. c. finely branched, widely separated; o. c. short, simple or finely branched; p. c.

2 to 8; i. o. simple or 2 or 3; o. o. 2 to 7; sh. stout, dark, bases confluent, inner 12 to 26, middle 8 to 15; t. pal. developed; abd. pal. I rudimentary; abd. pal. II to VII developed; lat. IV and V 4 to 5, half or less the length of III; lat. VI very short; ter. pl. small; ant. half of thorax, segments II, V, and VIII and sometimes VII totally white.

# 12. ANOPHELES LEUCOSPHYRUS. Plates 14 and 28; Plate 29, fig. F; Plate 31, fig. 4; Plate 32, figs. 5 and 10.

A medium-sized, light brown larva; i. c. finely branched, widely separated; o. c. simple; p. c. simple or forked; i. o. simple or branched 2 or 3; o. o. simple or branched 2 or 3; sh. fairly stout, bases confluent, inner 9 to 19, middle 8 to 15; t. pal. rudimentary; abd. pal. I and II rudimentary; abd. pal. III to VII developed, leaflets filamented and markedly serrated; lat. III more than 10 branches; lat. IV to VII about equal length 2 or 3; ter. pl. small.

# 18. ANOPHELES TESSELLATUS. Plate 25; Plate 32, figs. 1, 2, and 7.

A medium-sized, light to dark brown larva; i. c. finely branched, widely separated; o. c. very short, simple; p. c. very short, simple, rarely forked; i. o. 2 to 4, rarely simple; o. o. 2 to 4; sh. small, inner 3 to 6; middle 7 to 12; t. pal. fairly well developed; abd. pal. I and II rudimentary; abd. pal. III to VII developed, not pigmented, not filamented, not serrated or only faintly so; lat. III less than 10 branches; lat. IV to VI 2 or 3, rarely simple; ter. pl. small.

#### 14. ANOPHELES FILIPINÆ. Plate 5; Plate 83, fig. 8.

A small light brown or yellowish to dark brown larva; i. c. widely separated, finely branched; o. c. simple or branched laterally, branches few and short; i. o. 2 to 8; o. o. 2 to 8; i. s. p. 12 to 22 (branched less than either mangyanus or minimus var. flavirostris); m. s. p. 10 to 18; t. pal. developed; leaflets taper into long pointed filaments; abd. pal. all developed; a. pal. II and VII usually branched near apex; ter. pl. large, the one on II not concave or notched.

#### 15. ANOPHELES MANGYANUS. Plate 19; Plate 33, fig. 7.

A small very dark larva; i. c. simple, widely separated; o. c. simple; p. c. usually simple, rarely forked; i. o. 2 to 9; o. o. 3 to 10; sh. stout, dark; inner 15 to 26; middle 12 to 20; t. pal. developed, with leaflets extending into slender, very fine points; a. pal. VII simple, or forked distally; ter. pl. all large; II concave, IV to VII much rounded or blunt at the edges.

# 16. ANOPHELES MINIMUS var. FLAVIROSTRIS. Plates 1 and 20; Plate 33, fig. 6.

A small dark larva; i. c. simple, long, widely separated; o. c. usually simple, occasionally 2 or 3; p. c. usually simple, occasionally 2 or 3; i. o. 2 to 12; o. o. 2 to 13; sh. stout, dark; inner 18 to 30, middle 11 to 20; t. pal. developed, the leaflets not extended into slender fine points; abd. pal. I to VII all developed; a pal. VII branched basally; ter. pl. all large; II concave posteriorly; IV to VII tapering towards edges.

#### 17. ANOPHELES LITORALIS. Plate 16.

A medium-sized dark green to gray larva; i. c. simple, widely separated; o. c. simple, and long, sometimes nearly as long as the i. c.; p. c. long and simple; i. o. simple, rarely branched; o. o. 2 to 5 rarely simple; sh. inner 2 to 11; middle 2 to 10; t. pal. rudimentary; abd. pal. I rudimentary; abd. pal. II to VII developed; lat. IV to VI 2 or 3, branches originating nearer the base than those of *ludlowi*; pec. teeth not markedly different.

#### 18. ANOPHELES LUDLOWI. Plate 17.

A medium-sized gray-brown larva; i. c. simple, widely separated; o. c. simple, over half the length of i. c.; p. c. simple: i. o. simple, rarely branched; o. o. 2 to 7; sh. inner 8 to 16, middle 8 to 14; t. pal. rudimentary; abd. pal. I rudimentary; abd. pal. II to VII developed; lat. IV to VI 4 or 5; the branches of IV and V are farther away from the base than those of litoralis.

#### 19. ANOPHELES PARANGENSIS. Plate 21; Plate 31, fig. 2; Plate 33, fig. 4.

A medium-sized brown to gray larva; i. c. simple, widely separated; o. c. simple, rarely forked; p. c. simple; i. o. simple, rarely forked; o. o. 3 to 5; sh. typically more branches than subpictus var. indefinitus; inner 12 to 20; middle 12 to 19; t. pal. rudimentary; p. t. p. and m. t. p. each of these pleural hair groups has a feathered hair, unlike those of any other species of the ludlowi-rossi group; the other species may have a hair branched, at the most 2 or 4; abd. pal. I developed; leaflets usually broader and more widely spread than those of subpictus var. indefinitus; abd. pal. II to VII developed; lat. IV to VI 2 to 4 usually 3, near the base like subpictus var. indefinitus; ter. pl. small.

# 20. ANOPHELES SUBPICTUS var. INDEFINITUS. Plate 24; Plate 29, fig. C; Plate 32, figs. 4, 6, and 11; text figs. 1 to 4.

A medium-sized brown to gray larva; may have small white spots on thorax and abdomen; i. c. simple, widely separated; o. c. simple, more than half the length of i. c.; p. c. simple or forked, more than half the length of i. c.; i. o. simple, rarely

2 or 3; o. o. 3 to 7; p. t. p. no feathered hair; m. t. p. no feathered hair; sh. inner 7 to 16, rarely (as in Mindanao) 4 or 5, middle 6 to 16; t. pal. rudimentary; abd. pal. I to VII developed; lat. IV to VI 3; ter. pl. small.

# 21. ANOPHELES VAGUS var. LIMOSUS. Plate 26; Plate 32, fig. 9; Plate 33, fig. 1.

A medium-sized brownish to gray larva; i. c. simple (rarely forked), widely separated; o. c. simple, half or less length of i. c.; p. c. simple, relatively shorter than others of *ludlowi-rossi* group; i. o. simple, rarely branched; o. o. 3 to 9; sh. inner 10 to 18; middle 11 to 17; t. pal. rudimentary; abd. pal. I rudimentary; abd. pal. II to VII developed, leaflets generally narrower and not so spread out as those of *indefinitus* and *ludlowi*; lat. IV to VI usually 2 branches near base; pec. teeth short and long, markedly different.

# 22. ANOPHELES ANNULARIS (FULIGINOSUS). Plate 6; Plate 30, fig. B.

A medium-sized dark green to gray larva; no white markings on fresh specimens; i. c. widely separated, many fine branches on distal two-thirds; o. c. dichotomously branched; branches numerous and long; plumose; p. c. 2 to 5 (rarely simple); i. o. simple or forked; o. o. 3 to 7; i. s. p. stout, pigmented, bases confluent, inner 19 to 26; m. s. p. 12 to 18; t. pal. well developed; lat. IV to VI 2 to 5.

# 23. ANOPHELES KARWARI. Plate 11; Plate 29, fig. D; Plate 31, fig. 1; Plate 33, fig. 5.

A medium-sized greenish gray larva; i. c. finely branched, widely separated; o. c. finely branched laterally, branches short; p. c. simple and short; i. o. simple or branched; o. o. branched up to 5; sh. stout; inner 20 to 25; middle 17 to 21; p. v. s. m. 3 to 6 slender branches; t. pal. rudimentary; abd. pal. I rudimentary; abd. pal. II fairly well developed; abd. pal. III to VII well developed; filaments of leaflets short and knob-ended; lat. IV to VI 5 to 9, usually 7 (this is usually more than maculatus); IV and V are more than half the length of III; ter. pl. small.

### 24. ANOPHELES MACULATUS. Plate 18; Plate 29, fig. E.

A medium-sized brownish to light gray larva; i. c. finely branched, widely separated; o. c. usually finely branched, sometimes simple; p. c. simple, short; i. o. simple; o. o. 2 to 5; p. v. s. m. 3 to 6 slender branches; sh. stout, inner 14 to 21, middle 14 to 19; t. pal. rudimentary; abd. pal. I rudimentary; abd. pal. II to VII developed with broad leaflets, the filaments of which are long and pointed; lat. IV to VI 5 to 7, IV and V more than half the length of III; ter. pl. small.

### 25. ANOPHELES PHILIPPINENSIS. Plate 22.

A medium-sized larva easily recognized by its white markings on the thorax and abdomen, in fresh specimen; i. c. many fine branches on anterior two-thirds, widely separated; o. c. branched dichotomously, branches long and numerous, plumose; p. c. 2 to 4; i. o. 2 to 5. In some countries A. philippinensis is differentiated from A. annularis (fuliginosus) on the basis that the i. o. of the former is branched while in the latter it is This does not apply in the Philippines as this hair in our annularis (fuliginosus) is as often forked as it is simple. O. o. 3 to 5; sh. fairly stout, not pigmented. Bases not confluent, although this is not always clearly apparent. Rarely the bases of one or the other but not both are directly connected. A better criterion is the fact that the shoulder hairs of philippinensis are not pigmented, whereas those of annularis are always highly pigmented. This is especially useful in identifying mounted larval skins in which the position of the shoulder hairs is so distorted that the bases appear confluent, or else very widely separated. T. pal. developed; abd. pal. I to VII developed; lat. IV to VI 2 to 4, with branches more toward apex, generally, than those of annularis (fuliginosus).

# 26. Balabae species or variety (?). Plate 27; Plate 31, fig. 3; Plate 83, fig. 2.

Above medium size, light brown to brown; i. c. finely branched, widely separated; o. c. simple; p. c. simple, short; i. o. simple or forked; o. o. simple or forked; p. v. s. m. 3 to 6 slender branches; sh. stout but short, with large tubercle and confluent bases; inner 12 to 15, middle 10 to 11; t. pal. rudimentary; abd. pal. I rudimentary; abd. pal. II to VII developed; lat. III 11 to 15 or usually more branches; lat. IV and V 3, more than half length of lat. III; ter. pl. small.

# 27. ANOPHELES near-LEUCOSPHYRUS (?). Plate 28; Plate 31, fig. 4; Plate 32, fig. 5.

A medium-sized dark larva; i. c. widely separated, having more and coarser branches than any other member of the leucosphyrus group; o. c. over half the length of the inner, coarsely branched; p. c. longer than the outer, coarsely branched; i. o. usually simple, but may be forked; o. o. usually forked, but may be branched up to 4; rarely simple; p. v. s. m. 7 to 13 fairly stout branches; sh. inner 13 to 18; middle 10 to 16; t. pal. developed; abd. pal. I rudimentary; abd. pal. II to VII developed; lat. IV to VI long, 2 or 3 branched (usually 3).

It is possible that the Luzon leucosphyrus, the Mindanao leucosphyrus, and the "Balabac species or variety" are geographic

variants of the same species. "Near-leucosphyrus" appears to be a distinct species. Typically the Luzon specimens of leucosphyrus have rudimentary palmates II. This hair is more developed in the Mindanao form and is best developed in the Balabac larvæ. None seems to be A. leucosphyrus var. hackeri Edwards, 1921, as all have considerable variations from the typical larvæ of that species.

(The Balabac form, and also some taken at Iwahig, Palawan, have 9, 10, or 11 phallosomal leaflets in the adult males, the Mindanao form has up to 8, and the Luzon *leucosphyrus* has up to 7. The harpagonal spines of all three forms vary, being typically 2 but sometimes 3 or 4.)

# Key to the Philippine species of the genus Anopheles.

	reg to the 1 hutphile species of the genus incorporate.
1.	Inner clypeal hairs closely approximated 2.
	Inner clypeal hairs widely separated 11.
2.	Outer clypeal hairs simple or with short lateral branches (less than 10)
	Outer clypeal hairs with long dichotomous branches (more than 10) 7.
3.	Palmate I well developed
	Palmate I not developed, hairlike
4.	Lateral hair III having few branches insulæflorum.
	Lateral hair III feathery 5.
5.	Inner clypeal hairs having 2 to 4 main branches with or without fine
	subbranches aitkeni var. bengalensis.
	Inner clypeal hairs having 9 to 10 main branches without fine sub-
	branches
6.	Leaflets of abdominal palmate unfilamented; no distinct white markings
	on body of fresh specimen gigas var. formosus.
	Leaflets of abdominal palmate filamented; distinct white markings on
	body of fresh specimen lindesayi var. benguetensis.
7.	No true abdominal palmates baezai(?).
	Abdominal palmates present
8.	Stigmal club present; lateral hair VI about as long as those of IV and
	V pseudobarbirostris.
	Stigmal club absent; lateral hair VI very short
9.	Inner anterior submedian thoracic hair having 4 to 15 basal branches.
	barbirostris.
	Inner anterior submedian thoracic hair simple or having 2 or 3 apical
	branches10.
10.	Mesothoracic hair 5 having usually 3 or 4 straight branches; pro-
	thoracic hair 13 having long stem and 8 to 10 widely separated
	branches hyrcanus var. sinensis.
	Mesothoracic hair 5 having 6 to 8 slender curving branches; prothoracic
	hair 13 having short stem and usually 4 to 6 slightly separated
	branches
11.	Inner and outer clypeal hairs simple
	Inner clypeal hairs branched 18.
	2867803

12.	Palmate I developed
	Tergal plates large
13.	Tergal plates small 15.
4.4	Leaflets of thoracic palmate hairs extended into long slender filaments;
14.	antepalmate VII single or forked apically mangyanus.
	Leaflets of thoracic palmate hair not extended into long slender fila-
	ments; antepalmate VII branched basally.
	minimus var. flavirostris.
15	Each of pro- and mesothoracic pleural hair groups has a feathered hair.
10.	parangensis.
	Neither pro- nor mesothoracic pleural hair group has a feathered hair.
	subpictus var. indefinitus.
16.	Lateral hairs IV, V, and VI having 4 or 5 branches not close to the
	base ludlowi.
	Lateral hairs IV, V, and VI having 2 or 3 branches arising close to
	the base
17.	Short and long teeth of pecten markedly different; outer clypeal hair
	less than half the length of inner vagus var. limosus.
	Short and long teeth of pecten not markedly different; outer clypeal
	hair over half the length of the inner litoralis.
18.	Outer clypeal hair simple or having a few short lateral branches 19.
	Outer clypeal hair having numerous long dichotomous branches 27.
	Tergal plates large; first abdominal palmate rudimentary
20.	Palmate II developed
01	Palmate II undeveloped
21.	hair III; distinct white markings on body kolambuganensis.
	Lateral hairs IV and V more than half the length of lateral hair III.
	22.
22	Posterior clypeal very long and branched; prothoracic hair 13 having
	7 to 13 stout branches near-leucosphyrus.
	Posterior clypeal short and simple; prothoracic hair 13 having 3 to 6
	slender branches23.
23.	Lateral hairs IV to VI having 2 or 3 branches each 24.
	Lateral hairs IV to VI having 4 to 9 branches each
24.	Shoulder hairs with slender stem and branches; tubercles small and
	not confluent kochi.
	Shoulder hairs with stout stem and branches; tubercles large and often
	confluent
25	. Filaments of abdominal palmates II to VII having short knobbed ends.
	karwari.
	Filaments of abdominal palmates II to VII having long pointed ends.
26	maculatus.
40	Leaflets of abdominal palmates III to VII filamented and markedly serrated. Lateral hair III having more than 10 branches.
	serrated. Lateral hair III having more than 10 branches.  leucosphyrus.
	Leaflets of abdominal palmate III to VII not filamented and only slight-
	ly serrated if at all; lateral hair III having less than 10 branches.
	tessellatus.

philippinensis.

#### SUMMARY

This paper presents a practical guide to the identification of the larvæ of Philippine anopheline mosquitoes. It consists essentially of five parts; namely, (a) a synoptic table, (b) a series of brief descriptive notes, (c) a dichotomous key, (d) the same key in wall-chart form (printed separately), and (e) a series of descriptive drawings; all have reference to fourth-stage larvæ of the local anophelines.

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# ILLUSTRATIONS

### PLATES

The following numbers and letters apply to Plates 1 to 30. The descriptions of Plates 31 to 33 are given beyond. Only those parts are illustrated under each species which seem to be of practical use.

- 1. Clypeal hairs.
- 2. Antenna (showing antennal hair).
- 3. Shoulder hairs.
- 4. Thoracic palmate hair.
- 5. Mesothoracic hair 5.
- 6. Abdominal palmate hairs.
  - a. Palmate hair I.
  - b. Palmate hair II.
  - c. Palmate hair IV.
- 7. Lateral hairs.
  - a. Lateral hair III.
  - b. Lateral hair IV.
  - c. Lateral hair V.
  - d. Lateral hair VI.
- 8. Pecten.
- 9. Tergal plates.
  - a. Tergal plate II.
  - b. Tergal plate V.
- 10. Prothoracic hair 13 (prothoracic ventral submedian).
- 11. Prothoracic hair 14 (subcervical).
- 12. Pleural hair groups.
  - a. Prothoracic pleural hair group.
  - b. Mesothoracic pleural hair group.
  - c. Metathoracic pleural hair group.
- 13. Spiracular apparatus showing stigmal club.

PLATE 1. Anopheles minimus var. flavirostris; a typical anopheline larva.

- 2. Anopheles aitkeni var. bengalensis.
- 3. Anopheles baezai (?).
- 4. Anopheles barbirostris.
- 5. Anopheles filipinæ.
- 6. Anopheles annularis.
- 7. Anopheles gigas var. formosus.
- 8. Anopheles hyrcanus var. nigerrimus.
- 9. Anopheles hyrcanus var. sinensis.
- 10. Anopheles insulæflorum.
- 11. Anopheles karwari.
- 12. Anopheles kochi.
- 13. Anopheles kolambuganensis.

- 14. Anopheles leucosphyrus.
- 15. Anopheles lindesayi var. benguetensis.
- 16. Anopheles litoralis.
- 17. Anopheles ludlowi.
- 18. Anopheles maculatus.
- 19. Anopheles mangyanus.
- 20. Anopheles minimus var. flavirostris.
- 21. Anopheles parangensis.
- 22. Anopheles philippinensis.
- 23. Anopheles pseudobarbirostris.
- 24. Anopheles subpictus var. indefinitus.
- 25. Anopheles tessellatus.
- 26. Anopheles vagus var. limosus.
- 27. Balabac species (?).
- 28. Anopheles near-leucosphyrus (?).
- 29. Variations in clypeal hairs.
  - A. Anopheles aitkeni var. bengalensis (?); from Mount Banahao.
  - B. Anopheles aitheni var. bengalensis; with fine subbranches.
  - C. Anopheles subpictus var. indefinitus; unusual.
  - D. Anopheles karwari; finer branching.
  - E. Anopheles maculatus; very few branches.
  - F. Anopheles leucosphyrus; unusual branching.
- 30. Variations in clypeal hairs.
  - A. Anopheles barbirostris; from Balabac.
  - B. Anopheles annularis; branching of inner hair like those of philippinensis.
  - C. Anopheles lindesayi var. benguetensis; unusual inner clypeal hair.
  - D. Anopheles lindesayi var. benguetensis; fine branches on outer clypeal.
- 31. Pleural hair groups of some uncommon species.
  - 1. Anopheles karwari.
    - a. Prothoracic pleural hairs.
    - b. Mesothoracic pleural hairs.
  - 2. Anopheles parangensis.
    - a. Prothoracic pleural hairs.
    - b. Mesothoracic pleural hairs.
  - 3. Balabac species.
    - a. Prothoracic pleural hairs.
    - b. Mesothoracic pleural hairs.
    - c. Metathoracic pleural hairs.
  - 4. Near-leucosphyrus.
    - a. Prothoracic pleural hairs.
    - b. Mesothoracic pleural hairs.
    - c. Metathoracic pleural hairs.
  - 5. Anopheles baezai (?).
    - a. Prothoracic pleural hairs.
    - b. Mesothoracic pleural hairs.
    - c. Metathoracic pleural hairs.

- 32. Variations in shoulder and palmate hairs.
  - 1. Anopheles tessellatus; shoulder hairs.
  - 2. Anopheles tessellatus; shoulder hairs.
  - 3. Anopheles aitkeni var. bengalensis; shoulder hairs.
  - 4. Anopheles subpictus var. indefinitus; shoulder hairs.
  - 5. Anopheles near-leucosphyrus (?); palmate I.
  - Anopheles subpictus var. indefinitus; palmate I, same specimen as 4.
  - 7. Anopheles tessellatus; palmate IV, slightly serrated.
  - Anopheles hyrcanus var. sinensis; palmate IV, very narrow.
  - 9. Anopheles vagus var. limosus; palmate IV, very narrow.
  - Anopheles leucosphyrus; palmate IV, very narrow, slightly serrated.
  - 11. Anopheles subpictus var. indefinitus; thoracic palmate.
- 33. Variations in pectens. Some lateral hairs III, tergal plates, and a stigmal club.
  - 1. a and b Anopheles vagus var. limosus; pectens.
  - 2. a and b Balabac species (?); pectens.
  - 3. a and b Anopheles kochi; pectens.
  - a and b Anopheles parangensis; pectens, from one larva.
  - 5. a and b Anopheles karwari; pectens.
  - Anopheles minimus var. flavirostris; tergal plates II and V.
  - 7. Anopheles mangyanus; tergal plates II and V.
  - 8. Anopheles filipinæ; tergal plates II and V.
  - 9. Anopheles aitkeni var. bengalensis; lateral hair III.
  - 10. Anopheles insulæflorum; lateral hair III.
  - 11. Anopheles pseudobarbirostris; stigmal plate, lateral view; a, stigmal club; b, spiracle.

### TEXT FIGURES

- Fig. 1. Anopheles subpictus var. indefinitus; head, camera lucida drawing, semidiagrammatic.
  - 2. Inner clypeal hair.
  - 3. Outer clypeal hair.
  - 4. Posterior clypeal hair.
  - 5 to 7. Frontal hairs.
  - 8. Inner occipital or sutural hair.
  - 9. Outer occipital or transutural hair.
  - 11. Antennal or shaft hair.
  - 2. Anopheles subpictus var. indefinitus; dorsum of thorax, camera lucida drawing, semidiagrammatic, left half.
    - A. Prothorax.
      - 1. Inner submedian prothoracic hair.
      - 2. Middle submedian prothoracic hair.
      - 3. Outer submedian prothoracic hair.
      - 4 to 7. Lateral prothoracic hairs.
    - B. Mesothorax.
      - 5. This is one of the dorsolateral hairs 2 to 7.

- C. Metathorax.
  - 1. Thoracic palmate hair.
  - 2 to 7. Dorsolateral hairs.
- 3. Anopheles subpictus var. indefinitus; venter of thorax, camera lucida drawing, semidiagrammatic, left half.
  - A. Prothorax.
    - 9 to 12. Prothoracic pleural hair group.
    - 13. Prothoracic ventral submedian hair.
  - B. Mesothorax.
    - 9 to 12. Mesothoracic pleural hair group.
  - C. Metathorax.
    - 9 to 12. Metathoracic pleural hairs.
    - 13. Metathoracic ventral submedian hair.
- 4. Anopheles subpictus var. indefinitus; abdominal segments III to VII, dorsal view, camera lucida drawing, semidiagrammatic.
  - 1. Palmate hair.
  - 2. Prepalmate hair.
  - 3 and 4. Small dorsolateral hairs.
  - 5. Dorsolateral posterior hair.
  - 6 and 7. Lateral hairs.
  - Ter. pl. Tergal plate.
- 5. Spiracular apparatus: A. barbirostris and A. pseudobarbirostris.

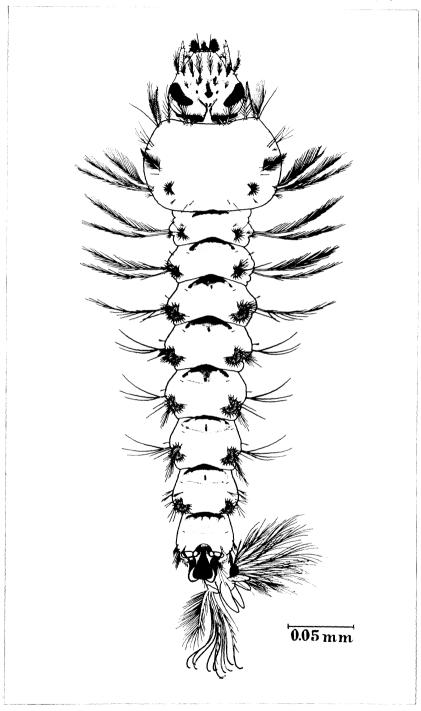


PLATE 1. ANOPHELES MINIMUS VAR. FLAVIROSTRIS.

	,	

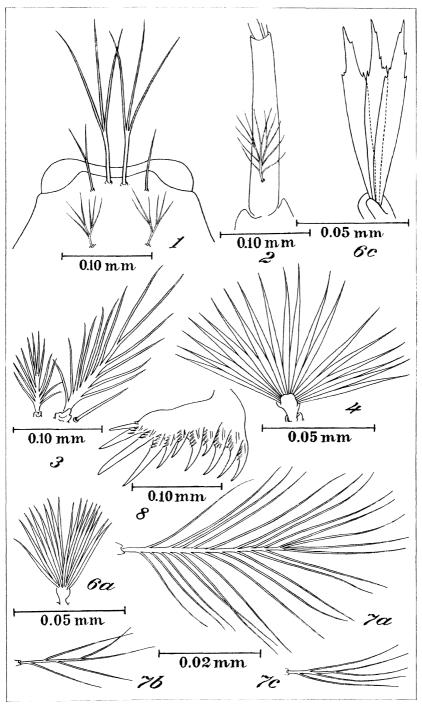


PLATE 2. ANOPHELES AITKENI VAR. BENGALENSIS.



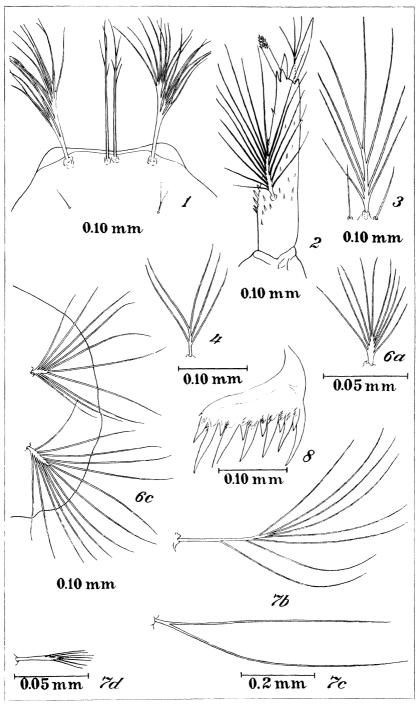


PLATE 3. ANOPHELES BAEZAI (?).

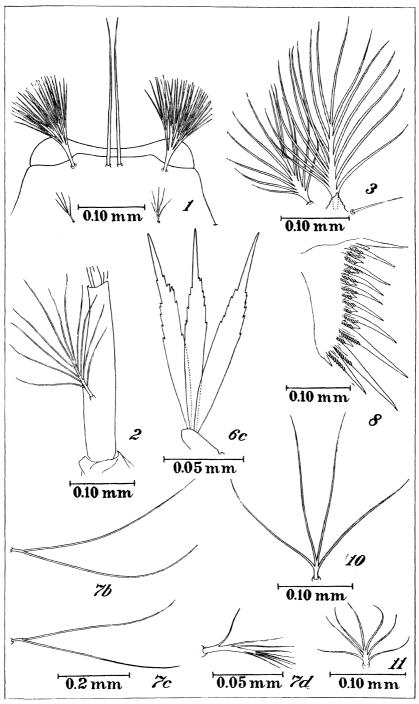


PLATE 4. ANOPHELES BARBIROSTRIS.

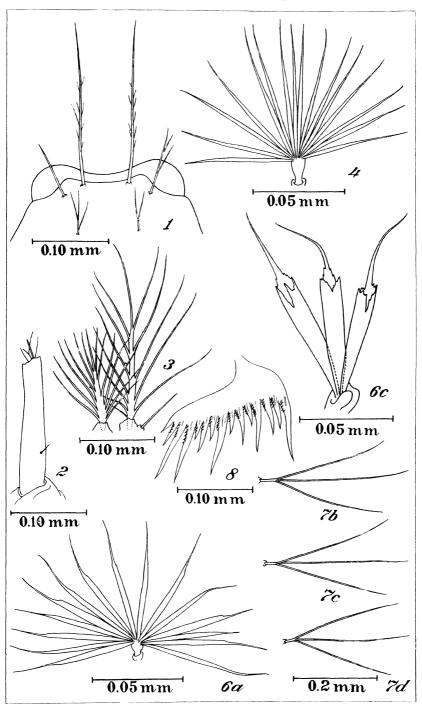


PLATE 5. ANOPHELES FILIPINÆ.



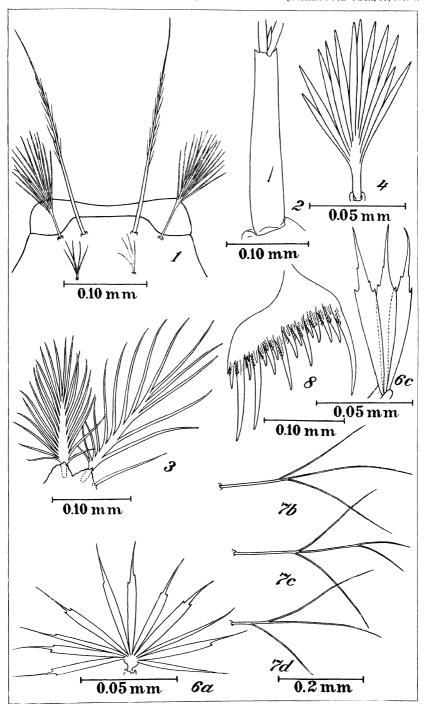


PLATE 6. ANOPHELES ANNULARIS.



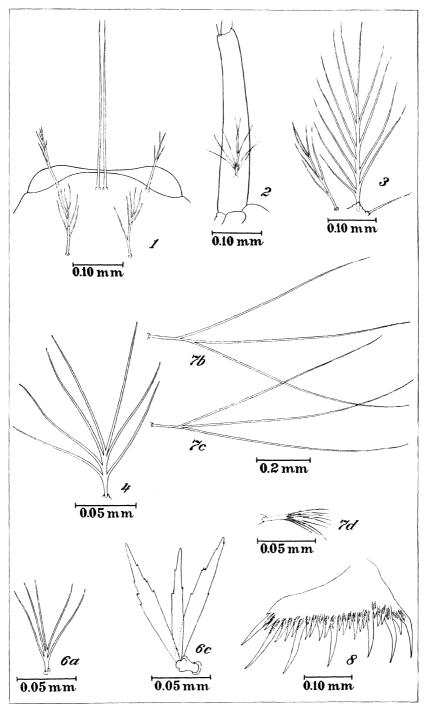


PLATE 7. ANOPHELES GIGAS VAR. FORMOSUS.

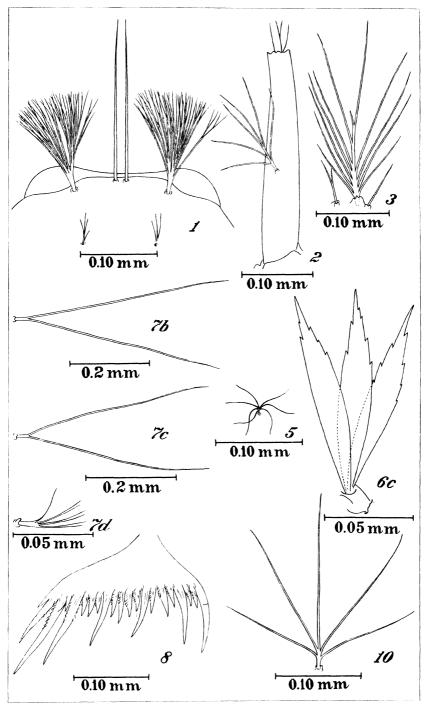


PLATE 8. ANOPHELES HYRCANUS VAR. NIGERRIMUS.

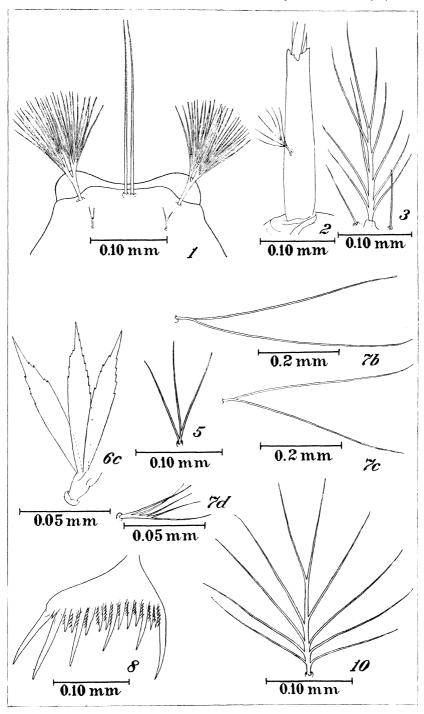


PLATE 9. ANOPHELES HYRCANUS VAR. SINENSIS.



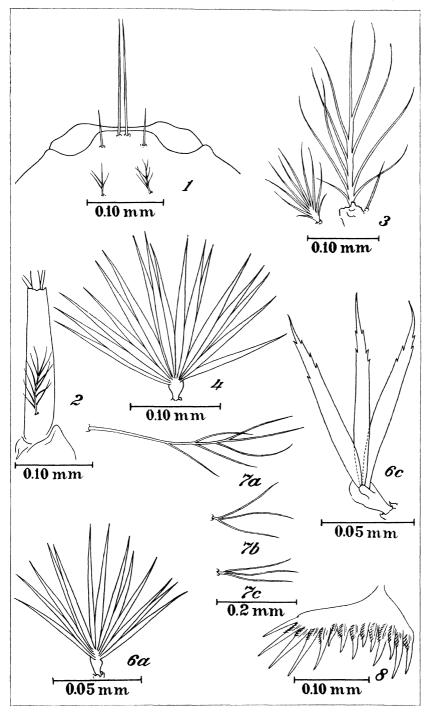


PLATE 10. ANOPHELES INSULÆFLORUM.



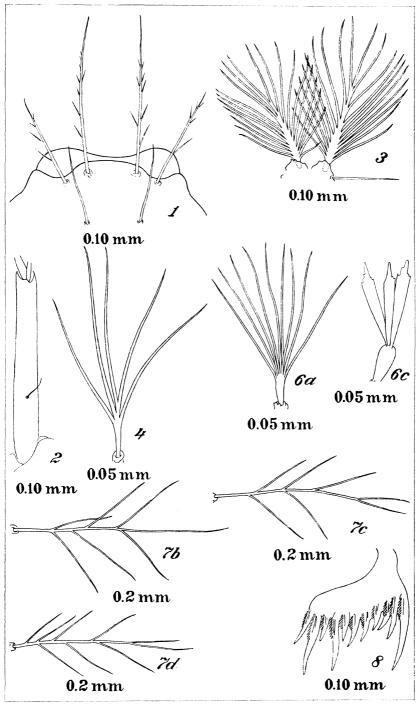


PLATE 11. ANOPHELES KARWARI.



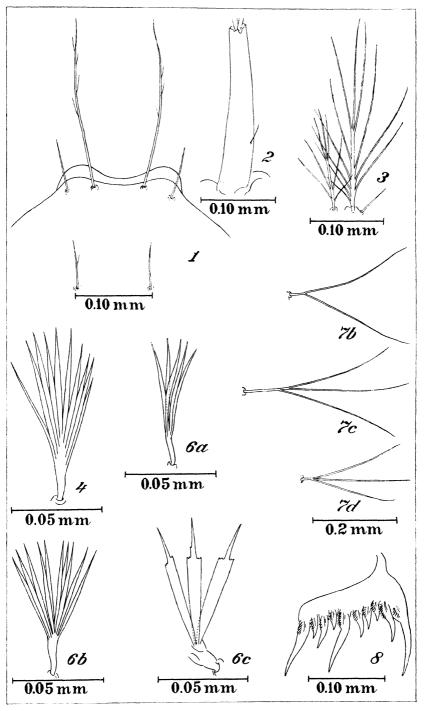


PLATE 12. ANOPHELES KOCHI.



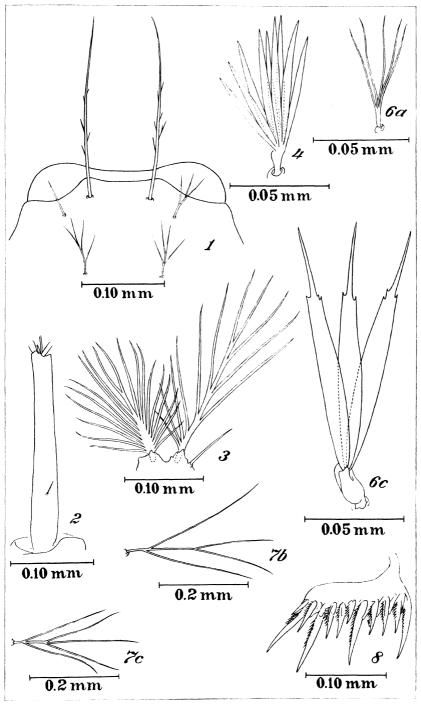


PLATE 13. ANOPHELES KOLAMBUGANENSIS.

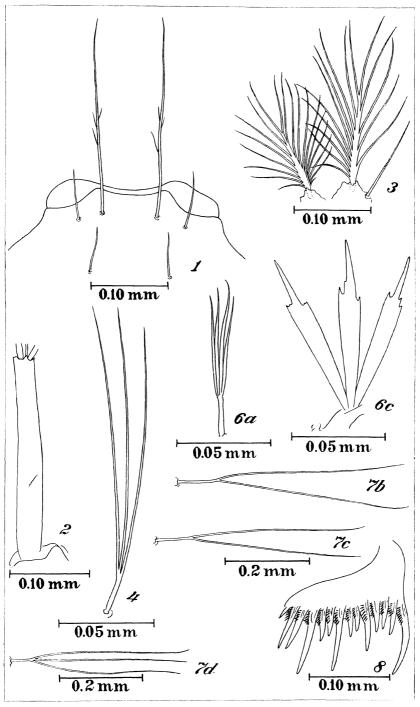


PLATE 14. ANOPHELES LEUCOSPHYRUS.



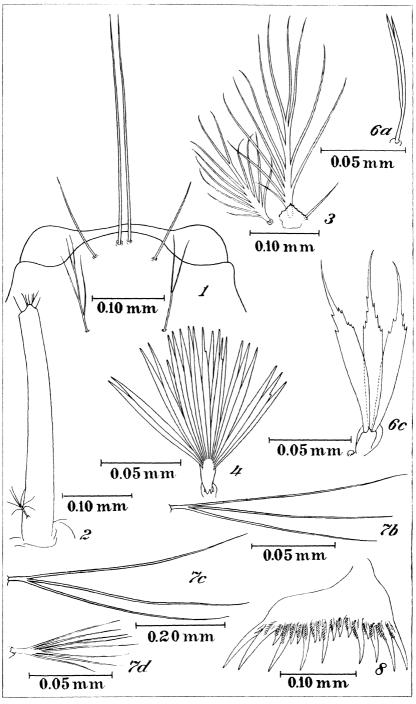


PLATE 15. ANOPHELES LINDESAYI VAR. BENGUETENSIS.



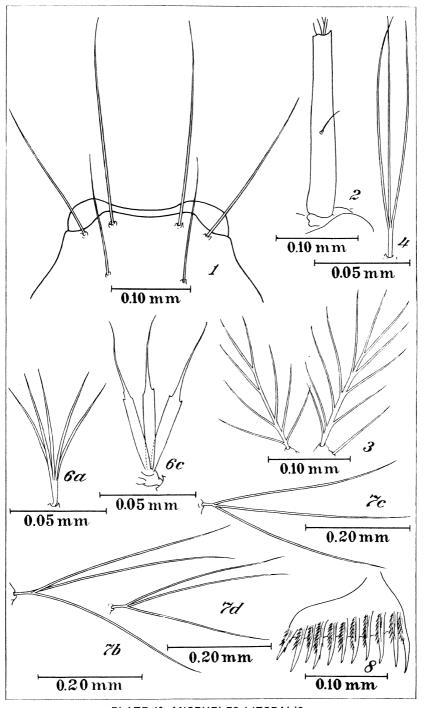


PLATE 16. ANOPHELES LITORALIS.



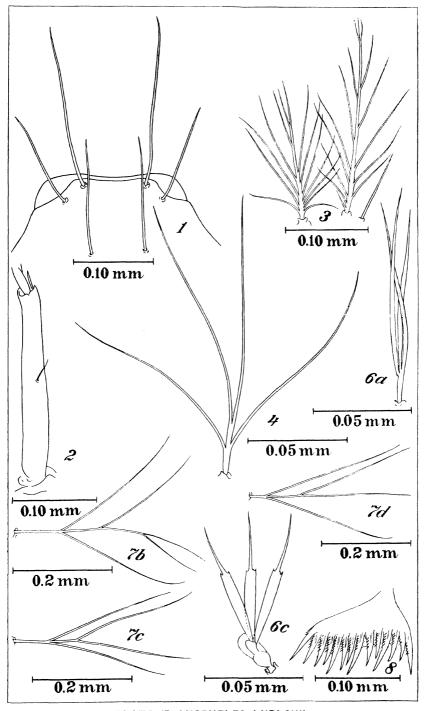


PLATE 17. ANOPHELES LUDLOWI.



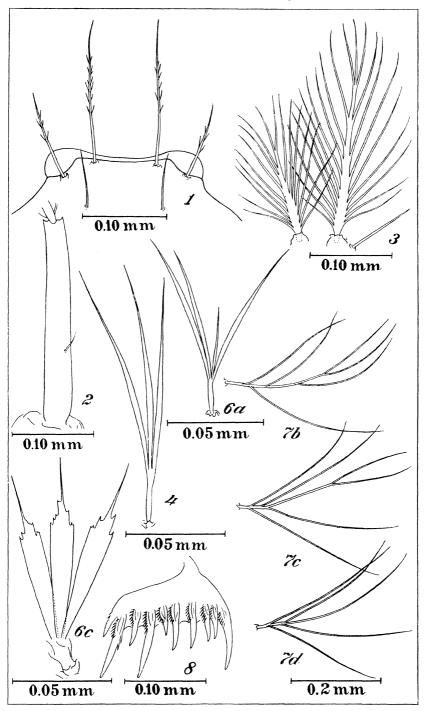


PLATE 18. ANOPHELES MACULATUS.



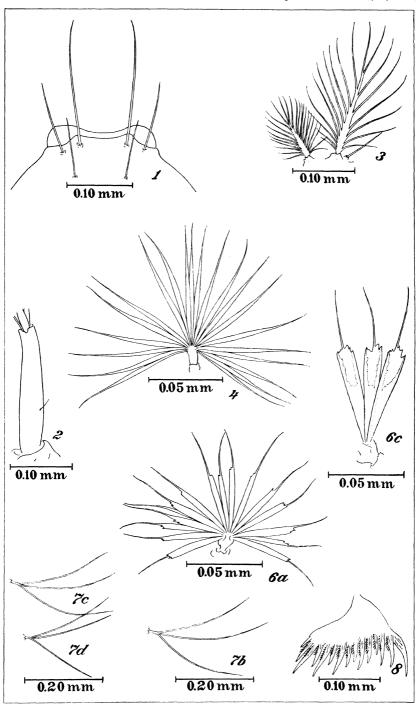


PLATE 19. ANOPHELES MANGYANUS.



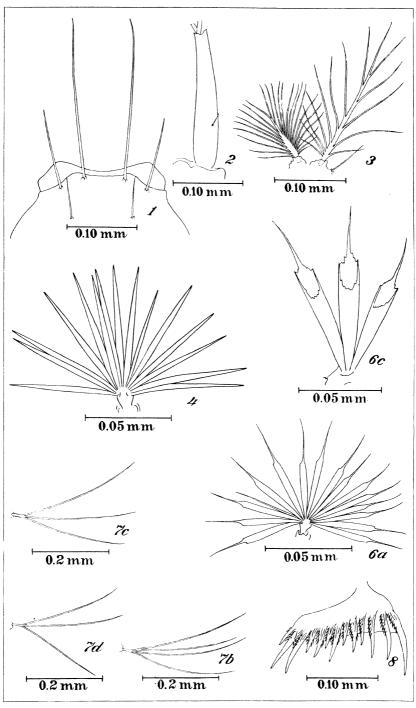


PLATE 20. ANOPHELES MINIMUS VAR. FLAVIROSTRIS.



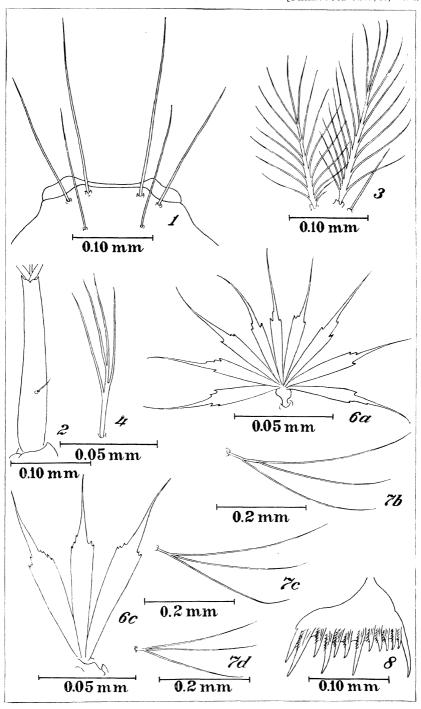


PLATE 21. ANOPHELES PARANGENSIS.



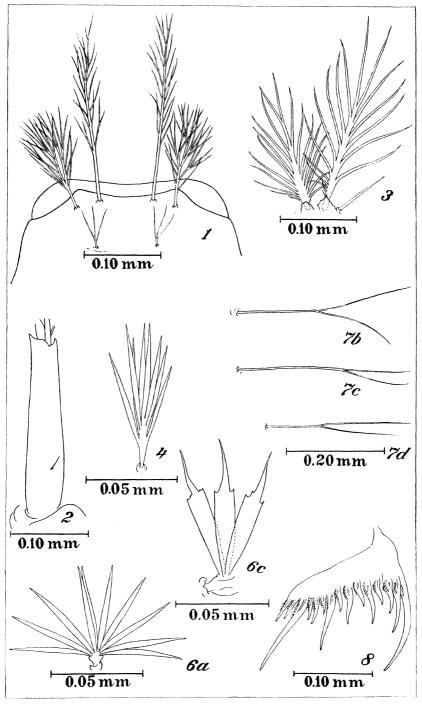


PLATE 22. ANOPHELES PHILIPPINENSIS.



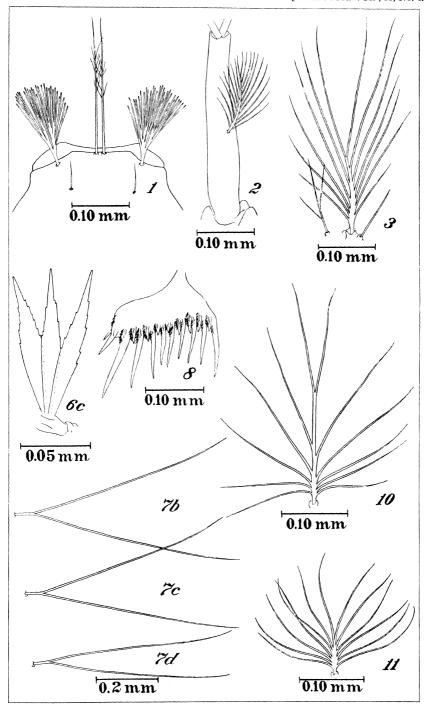


PLATE 23. ANOPHELES PSEUDOBARBIROSTRIS.



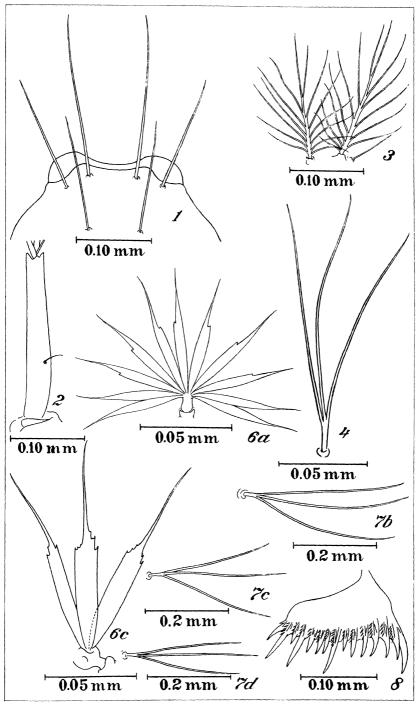


PLATE 24. ANOPHELES SUBPICTUS VAR. INDEFINITUS.



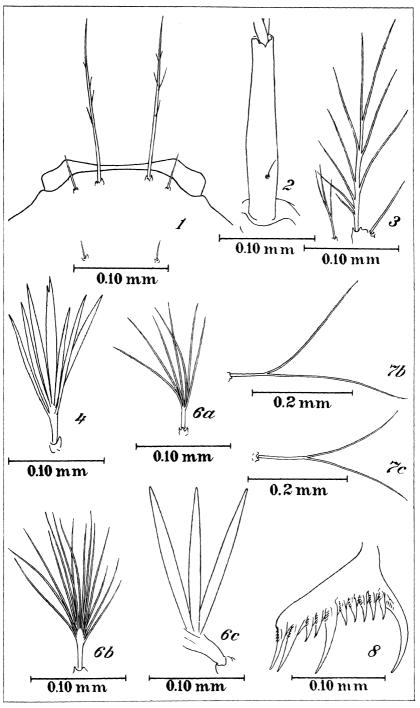


PLATE 25. ANOPHELES TESSELLATUS.



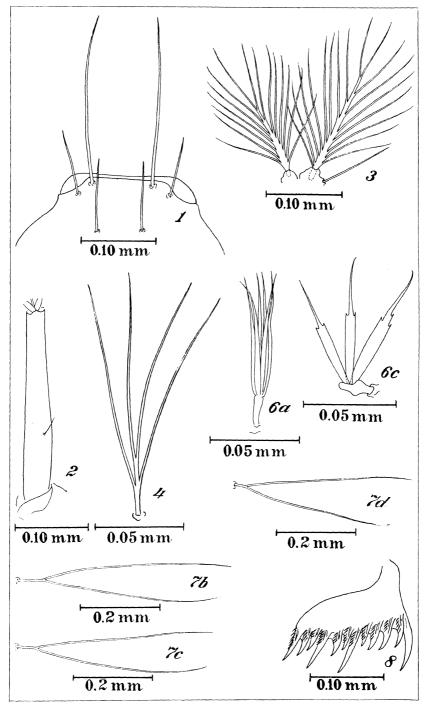


PLATE 26. ANOPHELES VAGUS VAR. LIMOSUS.



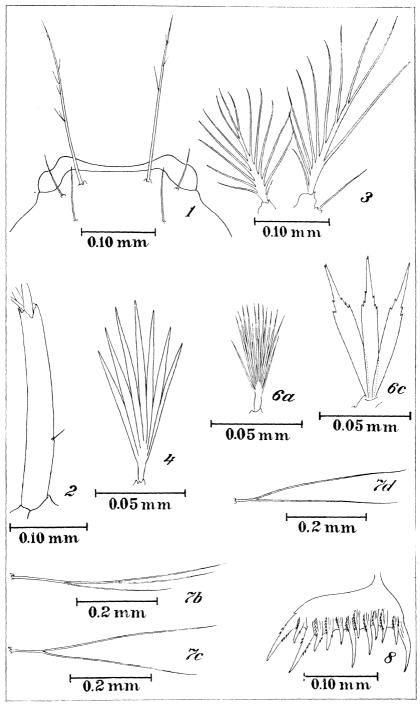


PLATE 27. BALABAC SPECIES (?).



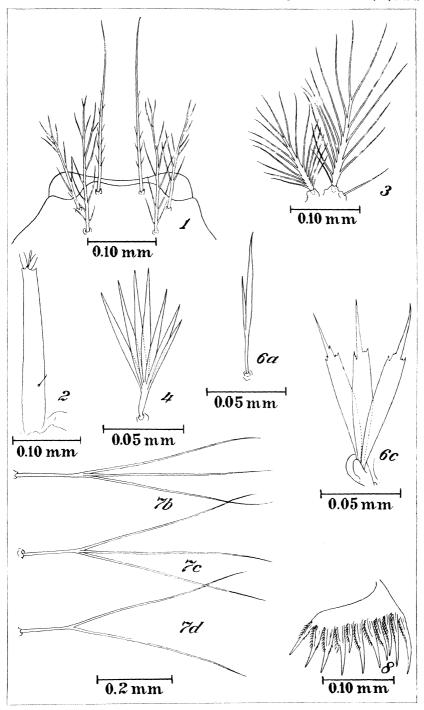


PLATE 28. ANOPHELES NEAR-LEUCOSPHYRUS (?).



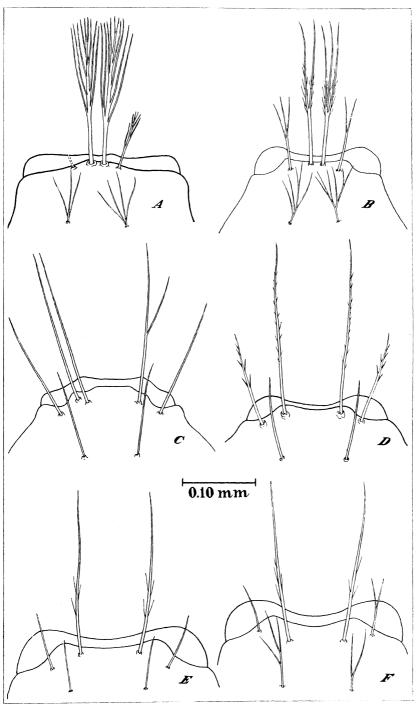


PLATE 29. VARIATIONS IN CLYPEAL HAIRS.



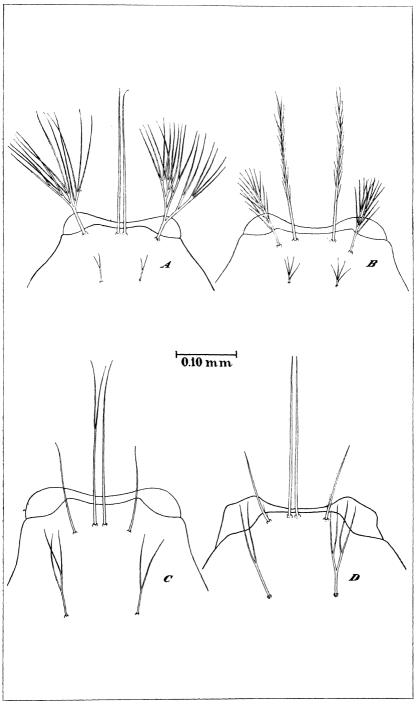


PLATE 30. VARIATIONS IN CLYPEAL HAIRS.



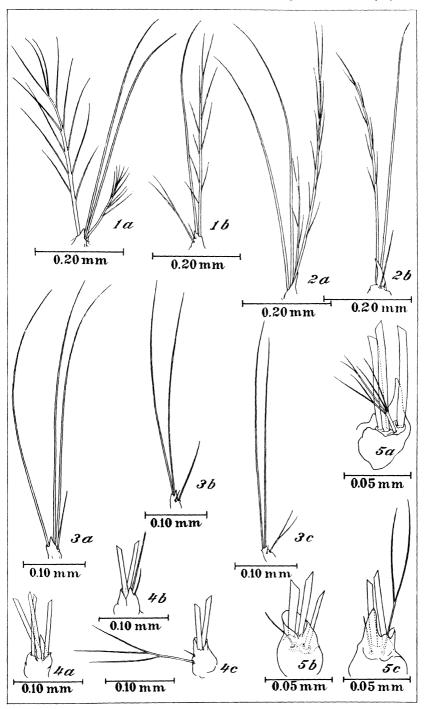


PLATE 31. PLEURAL HAIR GROUPS OF SOME UNCOMMON SPECIES.



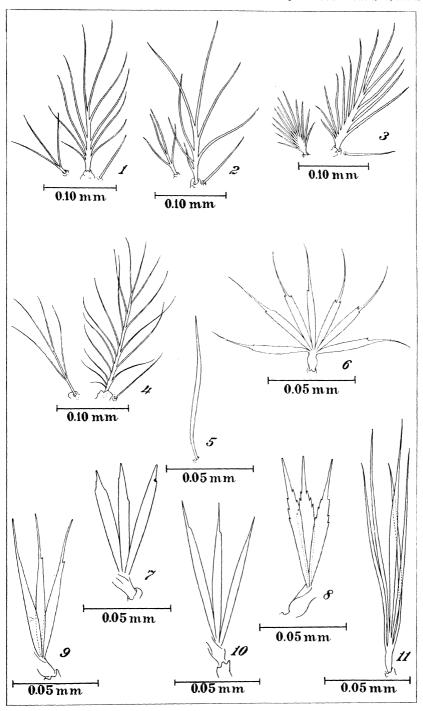


PLATE 32. VARIATIONS IN SHOULDER AND PALMATE HAIRS.



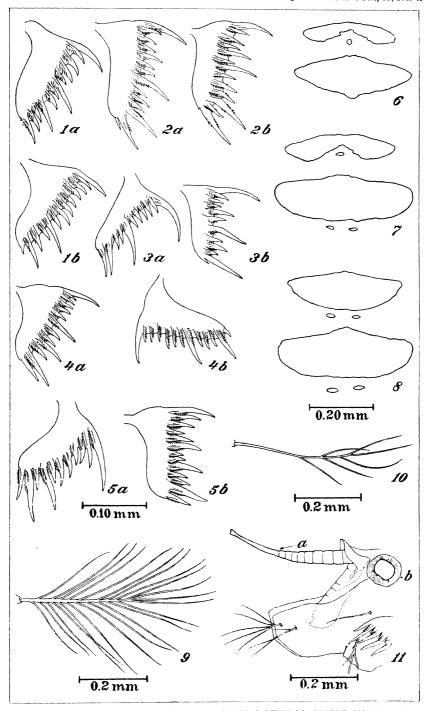


PLATE 33. VARIATIONS IN PECTENS. SOME LATERAL HAIRS III, TERGAL PLATES, AND A STIGMAL CLUB.



# FRUITLET BLACK-ROT OF PINEAPPLE IN THE PHILIPPINES 1

By F. B. SERRANO<sup>2</sup>

Of the Bureau of Science, Manila

#### SIX PLATES

#### INTRODUCTION

The fruitlet black-rot disease of pineapple, Ananas comosus (L.) Merr., was first noted by the writer as severely affecting fruits of the Smooth Cayenne variety and other unidentified hybrids in August, 1928, in Makar, Cotabato Province, Mindanao, where a few hectares of pineapple plantings were being cultivated by the Philippine Packing Corporation. Slicing hundreds of ripening fruits disclosed that 30 to 40 per cent were infected. Towards the end of the year and in the early part of 1929, the same infection was found on the Smooth Cayenne fruits in Santa Fe and Tangkulan, Bukidnon Province. Again in the summer months of 1931, 1932, and 1933, a study made on the Smooth Cayenne fruits coming from Cavite, Bulacan, Laguna, Nueva Ecija, and Pangasinan Provinces, in Luzon, resulted in the identification of the same trouble. The origin of the disease is not known. It is quite probable, however, that it was imported with Smooth Cayenne planting materials from Hawaii, where the disease is known to be present though not severe. fact that it is not found to affect any of the native varieties seems to justify this view.

# HISTORY AND GEOGRAPHIC DISTRIBUTION

As early as 1898, Tryon (20) studied in Queensland a disease of pineapple which he called fruitlet core-rot, affecting the Smooth

<sup>&</sup>lt;sup>1</sup> The second part of this article dealing with control measures will soon be published in this journal.

<sup>&</sup>lt;sup>2</sup> The writer wishes to express his gratitude to the Philippine Packing Corporation for its valuable help in making this investigation possible. Thanks are also due to Dr. E. Quisumbing, of the National Museum Division, for reading the manuscript and for the encouragement he has given me in its preparation.

Cayenne and Prickly Queen varieties. Penicillium and Monilia have been found in the spots and were thought to have gained entrance into the ovarian cavities of the fruitlet through wounds made by the pineapple mite (Tarsonemus ananas Tryon), in the flower bowl. Lucas(10) reported a somewhat similar disease of the Ripley and Queen varieties of pineapple in Jamaica, in 1907. Nowel(12) stated in his report of 1923 that Howard studied a black eye-spot disease of West Indian pineapples, in 1901, and found Penicillium associated with the spots. Pole-Evans(15) reported in 1924 a brown-spot malady of pineapple in South Africa which he found to be associated with the same fungus.

Whether or not the maladies mentioned above are identical with the Philippine fruitlet black-rot disease cannot possibly be ascertained owing to the incomplete descriptions of their symptoms and the inadequate study of their causal organisms. Among the available literature on the subject the only report which gives a description that tallies in almost every detail with the Philippine fruitlet black-rot is that of Barker, (1) from Cap Haitien, Haiti, in which he stated that he had isolated from the earliest stages of the disease a pale yellowish bacterium with rugose colonies, with which he was able to reproduce the typical black-rot disease through artificial infection.

# ECONOMIC IMPORTANCE

The result of examinations made of 6,936 fruits of the Smooth Cavenne variety in Cotabato and Bukidnon Provinces. Mindanao Island, from 1928 to 1930, showed that the infection by the fruitlet black-rot disease oscillated approximately from 27 to 47 per cent, of which about 12 per cent were unfit for can-Such an infection may not mean much loss to the dealers of fresh fruits, but it certainly gives a lot of inconvenience and trouble to the canners, in addition to the material loss which it entails. Table 1 shows that only 66.20 per cent of the fruits examined are healthy and free from any discoloration; 21.40 per cent are slightly affected, while the rest are so badly diseased that they are absolutely unfit for human consumption. of this seriousness and in view of the bright future of the pineapple industry in this country which may be jeopardized by the presence of this malady, it was deemed desirable to study the problem with the purpose of devising means of control.

9.39

3.01

		Number of fruits.	Observations.				
Year.	Place.		Healthy.	Slightly infected.	Severely infected.	Total loss.	
1928	Makar, Cotabato	128	63.8	24.4	10.1	1.7	
1929	Tangkulan, Bukidnon	1,440	67.3	29.6	2.8	0.8	
1929	do	2,814	73.2	24.8	1.3	0.7	
1930	Santa Fe, Bukidnon	352	62.2	23.1	11.1	3.6	
1930	do	220	73.1	18.5	6.7	1.7	
1930	do	807	72.4	20.3	5.9	1.4	
1930	do	352	62.2	23.1	11.1	3.6	
1930	do	369	64.0	17.0	15.3	3.7	
1930	do	238	55.3	18.2	16.7	9.8	
1930	do	216	68.6	15.0	12.8	3.6	

Table 1.—Showing percentages of healthy and infected fruits among 6,936

Smooth Cayenne fruits.

#### THE DISEASE

66,20

21.40

#### SYMPTOMS

To determine the character of the disease and its symptoms several hundred semiripe and ripe Smooth Cayenne fruits were cut into slices about 1 to 2 centimeters thick, and each slice was examined for internal discoloration. The infection is generally observed first in the trilobal fleshy placenta in the form of tiny spots or fine striations. The discoloration, which is best observed in cross sections, usually lies beneath the epidermis of the placenta and seldom penetrates it completely. It may extend to the other walls of the ovarial loculi, but as a rule it does not invade the interjacent tissues. It may involve, however, the entire fruitlet (Plate 2, fig. 2) and extend to the vascular bundles of the core when the infection is severe. A portion of the fruit, half of the fruit (Plate 1), or the whole fruit (Plate 2, fig. 1) may be infected, with the basal fruitlets more severely damaged than those on top.

In advanced cases of infection the color of the affected parts is dark brown to bone brown 3 or nearly black, and in cases of general infection affecting the entire fruit, or almost all the fruitlets, the fruit may remain firm and hard, the advanced

The colors indicated here and elsewhere in this paper are those of Ridgway's Color Standards and Color Nomenclature. Washington (1912).

stage of ripeness as shown externally by the yellow rind notwithstanding. Crispness and hardness of the affected parts seem to be outstanding characteristics of early, more or less complete infection.

There are no clearly visible external signs of the disease. Close and careful examination of the very bad cases of rots will reveal, however, that a fruit which has been completely infected during its early development, as may be judged from the extent and intensity of the internal discolorations, generally manifests a dull uneven ripening color, and firm hard texture which may be felt if the fruit is cut or pressed hard in the hands.

Similarity to and difference from fruitlet brown-rot.—This disease has so many things in common with the fruitlet brownrot(17) of pineapple that to a casual observer they appear as the same disease. These diseases appear more frequently together in the same fruit than separately. They attack the same parts of the fruit and invade the same tissues in a more or less identical manner, and both are caused by bacteria. There are a few dissimilarities, however, by which they may be distinguished from one another. As the names indicate the fruitlet blackrot has a decidedly darker internal discoloration than the fruitlet brown-rot and is, therefore, more objectionable from the canner's viewpoint. It is, besides, more serious and devastating than the brown-rot, thus entailing greater losses to the grower Furthermore, black-rot is caused by an entirely different bacterium, and has so far not been found to affect the native varieties. The only effective way of telling one from the other, however, is to isolate the causal organism.

# THE CAUSAL ORGANISM

Isolations from semiripe and ripe fruits.—To determine the flora present in the affected tissues, isolations from fruits having infections of various stages of development and showing different degrees of discoloration, were made in tubes of glucose bouillion + 1. This was done in the following manner: The fruits that showed infection, while cutting in the field was being conducted for general observation, were washed in running tap water to free them from dirt, then set aside to dry. When they became dry, new slices were made from each with a butcher's stainless-steel knife previously sterilized by dip-

ping in alcohol and flaming over an alcohol lamp; all the necessary pathological notes were taken at the same time. The surface of the discolored tissues was later singed with a red-hot spatula. Under observance of all necessary precautions to avoid contamination, up to ten small blocks in duplicate were aseptically scooped out, one by one, with the help of a scalpel, which was sterilized by dipping in alcohol and flaming over a flame before and after each operation, and planted each in a tube of glucose bouillion + 1. From each tube that showed turbidity after 24 to 48 hours' incubation at room temperature (25° to 30° C.), dilution plates were prepared. Transfers of the various distinct colonies that developed thereon were then made on potato glucose agar + 1.

Isolations from green or maturing fruits.—It was noted in the preceding isolation experiment that semiripe fruits are nearly as badly infected as the fully ripe ones. This is in complete accord with general observation in the field and in the factory. Therefore, bacterial infection may take place at some time during the development of the fruit. To throw light on this phase of the problem it became necessary to cut green or maturing fruits of the Smooth Cayenne variety into slices 1 to 2 centimeters thick and to examine each carefully for internal discoloration. Notes were taken on the pathologic condition of each specimen studied, and isolations made according to the same procedure and technic used in the first experiment.

Results of isolations.—The results obtained from the preceding two series of experiments are shown in Tables 2 and 3; the first gives descriptions of the various types of discoloration found in 200 fruits out of 600 examined, and the second also gives descriptions of the various types of discoloration found in 83 fruits out of 300 examined.

As given in Table 2 two kinds of bacteria were isolated with great frequency—the white and the yellow. Some other microörganisms, such as *Penicillium*, yeasts, a pinkish bacterium, etc., were also isolated, but owing to their erratic occurrence were dropped from the list.

It is shown in Table 2 that 35.50 per cent of the 200 infected fruits that were examined yielded pure cultures of the white bacterium, 23.50 per cent yielded pure cultures of the yellow bacterium, and 41 per cent yielded both the white and the yellow bacteria, at times occurring in the same plantings and at other

Table 2.—Showing bacterial flora most commonly found in 200 infected semiripe and ripe pineapple fruits.

		Fruits affected by—			
Fruits examined.	Description of discoloration.	White bacterium.	Yellow bacterium.	White and yellow bac- teria.	
20	Slight browning in scattered eyes with fine striations on placentæ.	6	6	8	
20	Complete infection in the form of slight browning and hardening in the eyes with streaks on pla- centæ and brown bundles in the core.	7	Б	8	
20	Complete infection in the form of brown hard eyes with soft brown rot in placentæ.	7	5	8	
20	Complete infection in the form of brown hard eyes with bone brown hard placentæ.	8	4	8	
20	Complete infection in the form of bone brown hard eyes with bone brown hard, rather dry pla- centæ and brown bundles in the core.	8	4	8	
20	Several brown hard eyes with few dark brown hard placentæ.	7	5	8	
20	Brown hard eyes and dark brown placentæ on ½ to § of top of fruits.	8	6	6	
20	Brown hard eyes and dark brown placentæ on } to } basal part of fruit.	8	4	8	
20	Brown hard eyes and dark brown placentæ on one side of fruit, top to bottom.	8	4	8	
20	Brown hard eyes at base with light brown streaks in fruitlets on top.	4	4	12	
	Fruits infectedper cent_	35.50	23.50	41.00	

times in different plantings, from the same fruit. It is further shown that on the average there are more cases of fruitlet rot associated with the white bacterium than with the yellow bacterium, and that the white bacterium is more or less constantly associated with bad, severe cases of infection. Finally, although, in general, the white bacterium is capable of causing more severe rots with darker shades of discoloration, as a whole, it produces a set of symptoms very similar to that caused by the yellow organism. This fact shows the impossibility of telling with certainty what particular kind of infection is found in a fruit by mere ocular examination.

Results of the isolations from green or maturing fruits as given in Table 3 are, in a general way, a confirmation of the first isolation tests—that the white and the yellow bacteria are the two organisms found mostly associated with the fruitlet rots.

Table 3.—Showing bacterial flora most commonly found in 83 infected green or maturing pineapple fruits.

Fruits examined.		Fruits affected by—			
	Description of discoloration.	White bacterium.	Yellow bacterium.	White and yellow bac- teria.	
47	Slight browning in scattered eyes with fine striations on placentæ.	20	12	13	
11	Complete infection in the form of slight browning and hardening of the eyes with streak on pla- centæ and brown bundles in the core.	4	8	4	
0	Complete infection in the form of brown hard eyes with soft brown rot in placentæ.	0	0	0	
0	Complete infection in the form of brown hard eyes with bone brown hard placentæ.	0	0	0	
0	Complete infection in the form of bone brown hard eyes with bone brown hard, rather dry placen- tæ and brown bundles in the core.	0	0	0	
3	Several brown hard eyes with few dark brown hard placents.	1	1	1	
0	Brown hard eyes and dark brown placents on 1 to 3 of top of fruit.	0	0	0	
9	Brown hard eyes and dark brown placentæ on 1 to 1 basal part of fruit.	3	3	8	
3	Brown hard eyes and dark brown placentæ on one side of fruit, top to bottom.	1	1	1	
10	Brown hard eyes at base with light brown streaks in fruitlets on top.	3	4	3	
	Fruits infectedper cent_	40.97	28.91	30.12	

Other microörganisms are as rare as they are erratic in occurrence and as such were discarded. These results differ from those of the first, however, in some particulars; namely, the infection in the latter is less severe with less-pronounced discoloration; and there are more cases of fruitlet rot associated with the white organism alone than there are of either the yellow alone or the white and the yellow in association.

In addition the following generalities may be deduced from the two series, first, that the infecting organisms apparently gain entrance into the placental cavity of the fruitlet some time during the development of the fruit or, to be more specific, during and after anthesis, either through the decaying flower parts or through fissures running from the eye cavity downward into the placental lobes and, in some instances, through the mechanical cracks generally present at the base of the eye cavity, particularly among large fruits; second, that the white organism is more active and virulent than the yellow even during the early stage of infection; and, third, that drying, hardening, and crispness of the affected tissues seem to be typical characteristics of the disease resulting from early severe infection.

#### PATHOGENICITY

Inoculation experiments.—With a view to determining the organism responsible for the occurrence of the fruitlet black-rot disease of pineapple five series of inoculations were conducted in Santa Fe, Bukidnon Province, beginning June, 1929. Only the white bacterium was used in these experiments inasmuch as the rest of the microörganisms had been tested and found to be associated with a more or less different type of spots, as reported by Serrano(17) in a paper on the bacterial fruitlet brown-rot of pineapple in the Philippines.

Series 1.—In this series 20 Smooth Cavenne fruits adjudged to ripen in about 40 days were used. The inoculation was done in the following manner: Twenty uniform upright fruits in a double row running from east to west were selected and tagged consecutively from 1 to 20. The first fruit was then disinfected all over with a 1:1000 solution of mercuric chloride in 70 per cent alcohol. As soon as they were dry a check puncture on each of the five eyes lined in a vertical order from top to base and facing the east (1-A) was aseptically made with a sterile steel needle. The needle was sterilized before and after the punctures were made by dipping in alcohol and flaming over an alcohol lamp. In every case proper care was observed to make the puncture at a definite angle so as to avoid the flower bowl where various microörganisms, particularly Penicillium and other molds, generally harbor. Then, in exactly the same manner five other punctures were made on the five opposite eyes facing west (1-B), but introducing with each puncture a mass of 48-hour-old culture of the white bacterium. Upon completion all punctures on both sides of the fruit were sealed with paraffin wax to prevent the entrance of extraneous microörganisms. The next nine fruits were treated in exactly the same way, using one separate culture of the white bacterium for each. Thus the first part (1-A to 1-B) of the first series was completed.

The second part (1–C to 1–D) is essentially the same as the first part, except that the inoculation was made by means of a 10-cc hypodermic syringe, injecting 1 cc of sterile distilled water as check into each of the five ovarial cavities facing east (1–C) and 1 cc of sterile water suspension of each of the same batch of cultures of the white bacterium used in the first series as inoculum into each of the five opposite ovarial cavities facing west (1–D).

Series 2.—This is a duplicate of the first series except that the fruits used were adjudged to ripen about 30 days from date of inoculation. The same ten batches of cultures of the white bacterium were employed, being inoculated by needle punctures in the first part and by hypodermic syringe in the second part.

Series 3.—The same procedure as in the first two series was followed with fruits adjudged to ripen about 20 days from date of inoculation.

Series 4.—Fruits adjudged to ripen about 10 days from date of inoculation were subjected to the same procedure as in the first three series.

Results of inoculations.—The fruits were picked and brought to the laboratory as soon as signs of ripening were noticed. Following the line of inoculation punctures every one of them was cut into longitudinal halves for observation (Plate 3). In this way the effect of the supposedly sterile puncture as well as the puncture with the inoculum on the ovarial lobes could be plainly observed. Every puncture was traced and meticulously examined for any discoloration in the cavity as well as on the placental lobes, and for any change that might have taken place in the texture of such tissues. The results of these examinations are given in Table 4.

The results obtained from the first series of inoculation experiments as given in Table 4 (1-A to 1-D) furnish a strong indication that the white bacterium is responsible for the occurrence of the fruitlet black-rot disease. All of the inoculated punctures in each of the 20 fruits turned out 100 per cent very strongly positive, while the check punctures on the same fruits remained negative (Plate 3). Most of the characteristic features of the disease in nature have been more or less completely reproduced. Brown lesions with dark brown irregular margins are in abundance in the inoculated fruitlets. Gumming, brown spotting on the placental lobes with fine reddish-brown striations, and browning of the vascular bundles are found in the

infected tissues. Crispness and hardening of the infected parts as found in nature are the only features of the disease not fully reproduced by artificial infection. Relatively few spots have shown a decided tendency to become really crisp and hard. This notwithstanding, the white bacterium was always regained by reisolation from infected tissues exhibiting such varied types of discolorations, while the check punctures remained sterile.

Table 4.—Showing results of inoculation experiments on 80 fruits adjudged to ripen in 40, 30, 20, and 10 days from date of artificial infection.

[+, Positive; ++,	strongly positive;	+++, ver	y strongly	positive;,	negative; x,	natural	
infection.1							

Series.	Number of fruits.	Method of inoculation.	Inoculum.	Observations.
1-A	1-10	50 punctures	None	50
1-B	1–10	do	White bacterium	50+++
1-C	11-20	50 injections	None	50
1-D	11-20	do	White bacterium	50+++
2-A	1-10	50 punctures	None	40-, 10x
2-В	1-10	do	White bacterium	40++,10+++
2-C	11-20	50 injections	None	50
2-D	11-20	do	White bacterium	43++,7+++
8-A	1-10	50 punctures	None	50
8-B	1-10	do	White bacterium	50++
8-C	11-20	50 injections	None	40, 10x
8-D	11-20	do	White bacterium	50++
4-A	1-10	50 punctures	None	45-, 5x
4-B	1-10	do	White bacterium	45+,5++
4-C	11-20	50 injections	None	50
4-D	11-20	do	White bacterium	40+,10++

Spreading of the discoloration is rather limited, the browning being found only in the tissues immediately surrounding the punctures. There are instances, however, where spreading occurred in the form of brown bundles in the core and tiny dots and fine reddish brown striations in the placental lobes.

The section of the fruit, or the stage or ripeness of the fruit seems to have some influence on the development and spread of the discolorations. Inoculation punctures made towards the top of the fruit usually produce cavities with leathery reddish brown to dark brown walls. These cavities are generally found with gum, whereas the inoculation punctures made on the midsection of the fruit down the base produced the types of discoloration approaching most the appearance of naturally infected fruits. The brown vascular bundles are present in

abundance in some positive cases but confined to the inoculated side of the fruit. Such browning of the bundles is invariably found originating from the inoculated eyes (Plate 3).

The inoculation made with the hypodermic syringe (1-C, Table 4) produces discoloration which decisively confirmed the results from the needle-puncture inoculations. With few exceptions the set of symptoms produced is the same as, and no more nor less characteristic than, in the puncture inoculations. Cavities with brown corky walls develop in the inoculated eyes above the midsection of the fruit, while lower down the tissues are rather soft spots with varied types of discoloration. Brown lesions with dark brown irregular margins and water-soaked gray centers are in abundance. A profusion of brown bundles and grayish brown wet placentæ are also often found.

As in the needle-puncture series the white bacterium is recovered in every instance by reisolations from these different types of discoloration, while the sterile-water infections as check remain sterile. The ten different isolations of this white bacterium vary somewhat among themselves, as will be discussed later, but when inoculated into the fruits their pathogenicity could not be clearly differentiated.

The results of Series 2 (Table 4, 2-A to 2-D) are essentially the same as those of Series 1. The same thing may be said of the results obtained from Series 3 and Series 4 (3-A to 3-D. and 4-A to 4-D, Table 4) where all of the inoculated fruits showed positive to very strongly positive infection. white bacterium is a very aggressive parasite of the pineapple fruit was clearly demonstrated by the positive results obtained from Series 4 when the fruits were picked and cut open for examination 10 days after the date of inoculation, while the The only characteristic features of checks remained sterile. the disease in nature not observed in this series are crispness and hardness of the affected placental lobes. These symptoms are probably reproducible only when the infection takes place while the fruits are still green, for at this stage of fruit development the upsetting of the metabolic processes in the plant system by the invading pathogen has a better chance of being decisive than at any other time.

As in the preceding series the white bacterium is recovered by reisolation from the various types of discolorations produced by artificial infection, with the checks remaining sterile, except a few, which evidently have been naturally infected at the beginning. All of these facts taken together would seem to prove that the fruitlet black-rot disease of pineapple is caused by the white bacterium.

Series 5.—After a more or less definite determination of the cause of the malady, the fifth and last series of inoculations was carried out in a seminatural manner as a confirmatory A block of twenty-four double rows (standard spacing, 56 by 22 by 18 inches) of Smooth Cavenne at bloom was selected for this experiment, May, 1930, in Santa Fe, Bukidnon Province. By the use of a compressed-air sprayer, row 1 was sprayed with tap water as check, and skipping 2 and 3 as blanket rows, row 4 was sprayed with water suspension of a three-day-old culture of the white bacterium, thoroughly wetting the inflorescences in both cases. In exactly the same manner and order, the remaining rows were treated at different intervals as follows: Rows 7 and 10, when the fruits were about two months old: rows 13 and 16, when the fruits were about three months old; and rows 19 and 22, when the fruits were about four months old and already maturing. Under these conditions of the experiment, the results may answer the question as to what particular stage of the fruit is most susceptible to the disease.

Results.—Fruits of the sprayed rows were picked and brought to the laboratory for observation as soon as signs of ripening were shown. As they were sliced, one by one, notes on their pathologic conditions were taken as presented in Table 5.

Table 5.—Showing results of inoculations by spraying fruits of different stages of development with the white bacterium.

	Treatment.	Age of fruits.	Fruits observed.	Pathologic observations.					Infection
Row.				Healthy.	Slightly infected.	Severely infected.	Total loss.	Total infection.	due to inocula- tion.
		Months.						Per cent.	Per cent.
1	Check	1	385	267	79	81	8	30.6	
4	Inoculated	1	390	86	195	78	31	77.9	47.3
7	Check	2	387	252	89	35	11	34.9	
10	Inoculated	2	389	97	195	74	23	75.0	40.1
13	Check	3	380	266	80	27	7	30.0	
16	Inoculated	3	395	134	188	57	16	66.0	33.0
19	Check	4	391	262	86	33	10	32.9	
22	Inoculated	4	386	178	157	41	10	53.9	21.0

Table 5 shows that the check rows gave a total infection of 30.6 per cent, 34.9 per cent, 30.0 per cent, and 32.9 per cent

with an average of 32.1 per cent; while the inoculated rows gave 77.9 per cent, 75.0 per cent, 66.0 per cent, and 53.9 per cent. The infections caused by the artificial inoculations are represented, therefore, by the difference between the two series, or 47.3 per cent, 40.1 per cent, 33.0 per cent, and 21.0 per cent. The positive results in the check were undoubtedly caused by natural infection.

It may be presumed that the pathogen gains access to the placental lobes of the fruit through decaying flower parts during the early stages of the development of the pineapple fruit, while during the later stages it may course its way in through other avenues besides, such as the mechanical cracks which are usually present at the bases of the three alternating stamens in large fruits, and the ruptures of the fissures running down from the eye cavity. In the light of these hypotheses it would seem reasonable to expect greater incidence of the disease from the fruits which have had the artificial inoculation during the latter part of their development than from those which had it earlier. fact as presented in Table 5 is contrary to this expectation, however. There are evidently two possible explanations of this; to wit, (a) the flowers or the fruitlets composing the fruit have their bracts still open during the early stages and are thus easily vulnerable to the attack of any parasite like the white bacterium which may happen to alight on them, whereas during the latter stages such bracts are generally more or less tightly closed, thereby excluding a great number of the invading microörganisms; (b) the plants to which the inoculum was introduced earlier were given a longer exposure to infection than those sprayed later.

Recapitulating, these results conclusively confirm the results of previous inoculations, that the white bacterium is the primary and only cause of the pineapple fruitlet black-rot disease; that the disease could be reproduced by inoculating the fruit with the white bacterium even without the aid of artificial injury to the fruit; that infection can take place at almost any stage of the fruit, although its incidence decreases as the fruitlets become more mature and tighten their bracts closely together; and, that some plants are apparently very resistant if not immune to the infection as represented by those which, in spite of the profuseness of the artificial inoculation given them, remained healthy till maturity. Such individuals when proven true to type should verily constitute a more or less permanent solution of this problem.

#### MORPHOLOGIC CHARACTERS

This organism is a short white rod with rounded ends, occurring singly, but usually in pairs, and sometimes in short chains. The size varies with the age of the culture. Single rods from 24-hour-old cultures on beef extract dextrose agar plates measure 1.7 to 2.0  $\mu$  by 0.5 to 0.6  $\mu$ ; those in pairs are 3.4 to 4.0  $\mu$  by 0.5 to 0.6  $\mu$ . Rods from 3-day-old and 6-day-old cultures were found to be smaller (Plate 5, figs. 3 and 4). The organism stains readily with most stains. It stains well with gentian-violet and with both concentrated and diluted (1:4) carbol-fuchsin. Carbol-fuchsin stains it in bands especially when the culture is rather old. It produces neither capsules nor spores. It is Gram-negative and not acid-fast. It is motile with 1 to 4 polar flagella, 3 to 4 times as long as the body, as shown by Plimmer's(14) method (Plate 5, fig. 2).

#### CULTURAL CHARACTERS

This study was carried out in the laboratories of the Bureau of Science with a view to identification of the causal organism. All cultures were kept at room temperature (25° to 30° C.) in the dark, under which conditions luxuriant growth of the organism, particularly on potato glucose agar + 1, was observed.

Beef-extract agar with 2 per cent dextrose.—This proved to be a favorable medium for the culture of this organism. Dilution plates produce colonies of about \(^3\)4 mm in diameter in 24 hours. In general the colonies are white with undulate to lobate edges, somewhat curled and finely granular; a few are not curled and have entire edges. The surface may be either smooth or rugose, radiately ridged, pulvinate to effuse. The submerged colonies are small and lenticular.

The growth is white at first but with the development of a pale greenish pigment it may assume an ivory-yellow color. The medium may be colored owing to the production of the pigment. The intensity of the pigment varies to some extent with the strain.

Colonies of certain strains are more or less constantly smooth, while others have a varying tendency towards rugosity. Rugosity seems to be accompanied by a dull appearance and smoothness by a glistening wet aspect. In the first few days the consistency is butyrous, becoming more or less viscid in 5 to 6 days, which is more marked in some of the strains than in others. There is, however, no apparent correlation between the varying characters of pigmentation, rugosity, or viscidity.

In slants moderate, filiform, flat, glistening growth develops generally with water of condensation after 24 hours. The streak spreads with a contoured, curly edge and wrinkling back of the margin. With age, say, 5 to 6 days later, the curly surface may turn smooth and glistening, and the mass of growth may ooze down to the base of the slant. The culture medium may be greened due to pigmentation.

Beef-extract agar.—This proved to be not as favorable a medium for the culture of this organism. The growth is scanty, and the colonies are considerably smaller. Except for feebleness the growth characters are as described in beef extract agar with 2 per cent dextrose.

Beef-extract broth.—The growth is feeble, producing slight cloudiness in 48 hours, and with flocculent surface growth and without sediment.

Beef-extract broth with 2 per cent dextrose.—Forty-eight hours after inoculation a thin wrinkled pellicle develops on the surface and the solution becomes slightly cloudy, but there is no precipitate. The pellicle is easily detached, dropping to the bottom and forming a flaky sediment. Dropping of the pellicle leaves a whitish ring attached to the glass at the surface. In 4 to 5 days the greenish pigment may be observed diffusing downwards from the pellicle.

Glycerine agar.—Forty-eight-hour colonies are pale ivory yellow, raised, smooth, with crenate edges; becoming barium yellow to straw yellow in 5 to 6 days; abundant, thick, rugose, and imparting strontian yellow to wax yellow pigment to the agar in two weeks, the color remaining apparently unchanged even after two months.

Potato-glucose agar + 1.—This proved to be a very favorable medium for the culture of the organism. Twenty-four hours after plating the colonies produced are about 1 mm in diameter, opalescent, convex, circular, entire, becoming pale greenish or ivory yellow, rugose, with crenate margin, and measuring 4 to 6 mm in diameter, after 2 days (Plate 4); abundant in 5 to 6 days, with colonies finally becoming smooth, round, creamy, wet, glistening, pulvinate to hemispherical, and imparting a pale greenish pigment to the medium (Plate 5, fig. 1). Rugosity and pigmentation vary somewhat with the strain. The medium may be greened due to the pigment.

In slants a filiform, flat, glistening growth with water of condensation develops in 24 hours. The streak spreads with a contoured, curly edge and wrinkling back of the margin. In

4 to 6 days the curly surface may turn smooth, glistening, starting from top to bottom, and the mass of bacteria may ooze down to the base of the slant (Plate 6). Simultaneously greening of the medium due to pigment production may be seen taking the same course.

Nutrient-gelatin stab.—Rapid stratified liquefaction occurs 24 hours after inoculation, accompanied by a slight production of greenish pigment and a heavy precipitate at the bottom. Liquefaction is complete after 2 days.

Milk.—A rennet curd with a layer of colorless whey on top is formed in 48 hours. Peptonization becomes apparent and is complete in 14 days.

Litmus milk.—A rennet curd is formed accompanied by peptonization. No trace of acid is observed even after 4 days, but litmus is slowly reduced and a yellowish whey is formed after a week.

Loeffler's blood serum.—Slight yellowish green growth develops on the surface of the slants 24 hours after inoculation. Liquefaction starts after 40 hours and is complete in 15 days.

Starch broth.—No diastatic action according to Eckford's (6) method; that is, the starch is not hydrolized.

Potato cylinders.—Rapid growth develops in 24 hours; abundant, glistening, with ivory yellow to cartridge buff after 4 days.

Pineapple juice.—The growth of the organism is fairly good on juice expressed from ripe fruit but scanty on juice from a mature or ripening fruit, the latter containing too much acid perhaps to support good growth.

Pineapple cylinders.—Unlike in the juice the growth is better on cylinders from mature or ripening fruit than on those from ripe fruit.

Cohn's solution.—Fairly good growth is produced with pellicles and little precipitate. The solution becomes turbid.

Uschinsky's solution.—Growth is manifested by slight cloudiness and slight precipitate in the solution.

## CHEMICAL PRODUCTS FORMED

Fermentation of sugars.—Two per cent solutions of glucose, lactose, saccharose, salicin, mannite, dulcite, maltose, and xylose were prepared in triplicates with Dunham's peptone water and Andrade's indicator<sup>(19)</sup> in Smith's fermentation tubes. With these preparations three strains of the white bacterium were tested.

Glucose.—Twenty-four hours after inoculation cloudiness and deep rose pink to deep rose coloration are produced in the bulbs of the fermentation tubes by all of the three strains, indicating good growth and the production of acid from glucose. In 48 hours a pellicle is formed. In 14 days the deep rose coloration fades out and the reaction becomes alkaline, owing to the production of alkali from peptone. There is no trace of growth whatsoever and no gas in the closed arms of the fermentation tubes.

Lactose.—Cloudiness is observed in the bulbs of the fermentation tubes in 48 hours but no pellicles develop. No acid is shown until after 70 days, and no signs of growth and no gas production in the closed arms of the bulbs are shown by any of the three strains used.

Saccharose.—There is a very slight cloudiness in the bulbs of the fermentation tubes in 48 hours but no pellicle, and no acid even after 70 days. There is no growth and no gas in the closed arms of the fermentation tubes. The final reaction of the solution is alkaline, showing that alkali is produced from peptone.

Salicin.—Cloudy after 4 days. No pellicle, no acid, and no growth in closed arms of fermentation tubes. No gas even after 70 days.

Mannite.—Turbid in 48 hours, and with little sediment after 4 days. No acid till after 5 weeks, no sign of growth, and no gas in the closed arms of fermentation tubes.

Dulcite.—Turbid after 48 hours, but no acid, no pellicle, no gas, and no sign of growth in the closed arms of fermentation tubes.

Maltose.—Good growth in 48 hours, with thin pellicle but no acid, no gas, and no sign of growth in closed arms of fermentation tubes.

*Xylose.*—Very good growth in 48 hours, with pellicle and little acid production after 3 days, the medium turning coral red; no gas, and no growth in closed arms of fermentation tubes.

Nitrate reduction.—Following the method recommended by the Committee on Bacteriological Technic of the Society of American Bacteriologists, (4) tests were made to determine the nitrate-reducing power of ten strains of the pathogen. Marked differences in the amount of nitrate produced were shown by each in 24 hours incubation; namely, three of the strains giving a decisively positive reaction and the rest slightly so or not at all. After 6 days of incubation six of the strains produced a dark blood red color with the reagents, which soon turned brown-

ish with a flaky precipitate, and the rest a rose color without precipitate.

When grown in peptone broth (A), nitrate peptone broth (B), synthetic nitrate medium (C), and peptone broth with the addition of 2 parts per million of potassium nitrate (D), for 6 days, and tested for ammonia by the Hansen(9) method, it gives negative results in (A) and positive results in (B). These phenomena simply indicate nitrate reduction by all the strains. Positive tests for nitrate in (C) with negative results for same in (D) conclusively confirm this fact.

These results would seem to show that the pathogen is a nitrate-reducing organism and that its power as such varies with the different strains.

Hydrogen sulphide production.—None of the strains tested produce hydrogen sulphide as shown by Feller's (7) method.

Indol production.—Following the Gnezda (8) test, no indol production is shown by any of the strains.

#### PHYSIOLOGICAL REACTIONS

Relation to oxygen.—The agar shake culture method (4) has shown that the white bacterium is a strict aërobe.

Relation to temperature.—Very scanty growth at  $7^{\circ}$  to  $10^{\circ}$  C. Optimum temperature lies between  $31^{\circ}$  and  $33^{\circ}$  C. and the maximum between  $43^{\circ}$  and  $45^{\circ}$  C. Thermal death point lies between  $51^{\circ}$  and  $53^{\circ}$  C.

Relation to media.—Beef-extract broth with 2 per cent dextrose was prepared in 13 sets of 10 test tubes each, with the following reactions corresponding to each set in numerical order before and after sterilization: pH 3.0, 3.3, 3.6, 3.9, 4.2, 4.6, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, and 8.0; and pH 3.14, 3.31, 3.63, 3.93, 4.36, 4.62, 4.98, 5.50, 5.93, 6.55, 7.06, 7.49, and 8.04. The pH values were determined by colorimetric method. (5)

Three strains of the white bacterium produced cloudiness after 24 hours incubation in culture having pH 4.36 to 7.49, and with distinct pellicles in cultures having pH 4.98 to 5.93, while others remained apparently negative. After 48 hours cultures having pH 3.93 and 8.04 showed slight turbidity, denoting scanty growth. Even after a week cultures having pH 3.14, 3.31, and 3.63 remained sterile, strongly indicating that the acid present is too much to allow any vegetative growth of the pathogen. From these results the optimum acidity for the pathogen would seem to lie between pH 5.0 and 6.0.

Relation to sugar.—Beef-extract broth was prepared in 7 sets of 10 test tubes each representing different amounts of sugars; namely, to the first set, no sugar added as check; to the second set, 3 per cent (2 sucrose and 1 dextrose); to the third set, 6 per cent (4 sucrose and 2 dextrose); to the fourth set, 9 per cent (6 sucrose and 3 dextrose); to the fifth set, 12 per cent (8 sucrose and 4 dextrose); to the sixth set, 15 per cent (10 sucrose and 5 dextrose), and to the seventh set, 18 per cent (12 sucrose and 6 dextrose). This proportion of sugars is similar to what was found in pineapple fruits (17) grown under natural conditions.

Three strains of white bacterium tested produced cloudiness after 24 hours incubation in all cultures except in the seventh which showed only very scanty flocculent growth on the surface of the liquid along the sides of the test tubes. The third exhibited by far the most luxuriant growth followed closely by the second and fourth, all with pellicles. The same order of development continued even after a week, which goes to show that about 6 per cent is the optimum sugar requirement for the best growth of the pathogen.

## TECHNICAL DESCRIPTION

#### PHYTOMONAS ANANAS sp. nov.4

White rod-shaped type with rounded ends; occurring singly, but usually in pairs, and sometimes in short chains; size very variable depending on age—24-hour-old culture measuring on the average 1.8  $\mu$  by 0.6  $\mu$ —older cultures smaller; motile with 1 to 4 polar flagella, 3 to 4 times as long as the body; no capsules, no spores; Gram-negative and not acid-fast; readily stained with carbol-fuchsin and gentian-violet; a strict aërobe and capable of producing green pigment.

Agar colonies white, becoming ivory yellow, with undulate to lobate edges; somewhat curled and finely granular; a few are not curled and have entire edges; the surface may be either smooth or rugose, radiately ridged, pulvinate to effuse, becoming profuse, smooth, wet, glistening, pulvinate to hemispherical, and imparting a pale greenish pigment to the medium; consistency

<sup>4</sup> Following Bergey's Manual of Determinative Bacteriology (2) this pathogen is classed under *Phytomonas*, and the name *Phytomonas ananas* is proposed. None of the 77 species described by Burkholder (3) is identical with this. It should be *Pseudomonas ananas* under Migula's (11) classification, and *Bacterium ananas* if Smith's (18) classification is followed.

butyrous, becoming more or less viscid; submerged colonies small and lenticular; streak growth moderate, filiform, flat, spreading with a contoured, curly edge, wrinkling back of the margin and becoming smooth, glistening with age; profuse growth on potato-glucose agar + 1 and beef-extract agar with 2 per cent dextrose; in beef-extract broth with 2 per cent dextrose, wrinkled pellicles develop one after another, and soon settle to the bottom, forming a flaky sediment; the broth becomes cloudy but without precipitate; in 4 to 5 days a greenish pigment diffuses downward from the pellicle; liquefies nutrient gelatin and Loeffler's blood serum; forms soft curd in milk and litmus milk, accompanied by peptonization and formation of whey and alkali, litmus slowly reduced, but no acid formed; starch not digested or hydrolized; readily ferments glucose with production of acid but no gas; ferments also xylose, mannite, and lactose feebly, but not saccharose; reduces nitrate to nitrite; produces neither hydrogen sulphide nor indol; optimum temperature within 31° to 33° C.; thermal death point lies between 51° and 53° C.; grows best at about ph 5.5 with about 6 per cent sugar. The organism is pathogenic on pineapple. particularly the Smooth Cayenne variety.

*Index number.*—Following the chart recommended by the Society of American Bacteriologists (13) the index number is 5322-31124-2223.

# PATHOLOGIC ANATOMY

As already mentioned in the discussion of the results of isolations, the internal discolorations resulting from this bacterial invasion have their origin traceable from the mechanical cracks generally present at the base of the eye cavity, particularly among large fruits, and the fissures running from the eye cavity downward into the placental lobes and ovarial loculi, thence into the tissues of the entire fruitlet and vascular bundles in the core, especially when infection is severe.

The pathogen may gain access to the placental cavity of the fruitlet sometime during the development of the fruit; namely, during and after anthesis either through the decaying flower parts, through ruptures of the fissures running from the eye cavity downward into the placental lobes, or through the mechanical cracks generally present at the bases of the three alternating stamens in large fruits. Such fruits are by nature possessed of large eyes with bracts seldom tightly closed even at maturity, thus remaining partly exposed to infection. That

greater pathologic infection is met with in this type of fruits than in others, seems to suggest that incomplete closing of the bracts of the eyes predisposes the pineapple fruits to all sorts of infections, most particularly to the fruitlet black-rot pathogen. Hence, fruits of this type are susceptible to the black-rot disease even after they have more or less fully developed.

Sections from the placentæ and core showing the typical symptoms of the disease in nature as well as those from positive inoculations were fixed in Carnoy's fluid, Flemming's solution, and formal-acetic-alcohol.

The method employed by Riker(16) in demonstrating the crowngall organism in its host tissue was used to advantage in staining the preparations. In addition many other stain combinations were tried, and carbol-fuchsin with a saturated solution of methyl-orange in clove oil as a counterstain was found to give the best results. With this combination the diseased cell walls and xylem elements stain red while the healthy cell walls stain yellow.

The intercellular spaces and the adjacent parenchymatous cells of the brown vascular bundles in the core are filled with granular refractive masses which readily stain with the nuclear stains. It is highly probable that these extraneous phenomena, not being found in healthy tissues, are masses of the pathogenic bacterium which has been invariably isolated from the duplicates of such materials.

#### SUMMARY

- 1. A bacterial fruitlet black-rot disease of the pineapple in the Philippines is described. The disease is one of the two major maladies of the pineapple, causing an infection of about 37 per cent on the average. It is found in all districts of the Archipelago where the Smooth Cayenne variety is grown.
- 2. The disease is characterized by dark brown to bone brown or nearly black discolorations in the placental lobes and placental loculi of one or more or all of the fruitlets which may involve the entire fruitlet or fruitlets and the vascular bundles of the core. It generally does not manifest itself externally and, like the brown-rot, is very difficult to diagnose without cutting the fruit. Very severely infected fruits are, however, distinguishable from the rest by being extraordinarily hard and having an uneven ripening color, even in an advanced stage of ripeness. It is evidently identical with the fruitlet black-rot disease of the pineapple in Haiti as reported by Barker.

- 3. The causal organism of the disease is a white bacterium hitherto unknown and is named *Phytomonas ananas* sp. nov. Inoculations with this white bacterium, with or without artificial injury to the fruit, have invariably reproduced the typical symptoms of the disease, conclusively establishing its pathogenicity. A technical description of the pathogen is given.
- 4. Evidence gathered would seem to suggest that the pathogen gets into the fruitlets during fruit development through decaying flower parts, mechanical cracks which are generally present in large fruits, and ruptured fissures running from the eye cavity downward into the placental lobes.
- 5. Some individual plants are apparently very resistant, if not immune, to the infection as represented by those which, in spite of the profuseness of the bacterial infusion sprayed on them, remained healthy till maturity.

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# **ILLUSTRATIONS**

#### PLATE 1

Ripe Smooth Cayenne fruit cut longitudinally into halves, showing severe fruitlet black-rot infection on one side with brown bundles running from infected eyes; about × 1/3. (Photograph by C. S. Angbengco.)

#### PLATE 2

- FIG. 1. Cross section of ripe Smooth Cayenne fruit showing severe fruitlet black-rot infection throughout; about × 1/2. (Photograph by C. S. Angbengco.)
  - Fruitlets of ripe Smooth Cayenne fruit showing different stages of fruitlet black-rot infection; about × 1. (Photograph by C. S. Angbengco.)

#### PLATE 3

Ripe Smooth Cayenne fruit cut longitudinally into halves following the line of needle-puncture inoculations, showing characteristic browning of the infected fruitlets on one side in contrast with the unchanged natural cream color of the check fruitlets on the opposite side. Note also the brown bundles running from the infected fruitlets of the inoculated side; about × 1/3. (Photograph by C. S. Angbengco.)

#### PLATE 4

- Fig. 1. Two-day-old plate culture of *Phytomonas ananas* sp. nov. on potato glucose agar + 1.
  - Same as fig. 1, enlarged; showing colonies with undulate to lobate, more or less curled edges, with either smooth or curled, radiately ridged, pulvinate to effuse, surface; about × 3. (Photograph by C. S. Angbengco.)

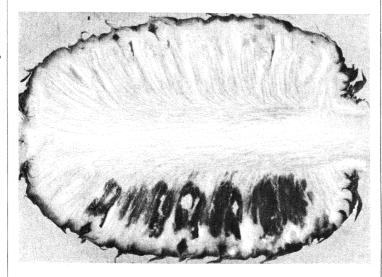
### PLATE 5

- Fig. 1. Six-day-old plate culture of *Phytomonas ananas* sp. nov. on potatoglucose agar + 1. Note that, in contrast with Plate 4, the colonies have become smooth, round, creamy, wet, glistening, pulvinate to hemispherical, with edges more or less entire, and forming somewhat transparent concentric rings; about × 3. (Photograph by C. S. Angbengco.)
  - Phytomonas ananas sp. nov.; smear preparation from 24-hour-old plate culture, stained by Plimmer's (14) method to show flagella. Note 1 to 4 polar flagella, 3 to 4 times as long as the body. Rods are mostly in pairs; about × 1,120. (Photomicrograph by F. B. Serrano.)

- Fig. 3. Phytomonas ananas sp. nov.; smear preparation from 3-day-old plate culture, stained with dilute (1:4) carbol-fuchsin, showing decrease in size; about × 1,120. (Photomicrograph by F. B. Serrano.)
  - 4. Phytomonas ananas sp. nov.; smear preparation from 6-day-old plate culture, stained with dilute (1:4) carbol-fuchsin, showing further decrease in size of individual rod, and its slow reaction to staining. Most of the bacteria especially those in chains stain in bands; about × 1,120. (Photomicrograph by C. S. Angbengco.)

#### PLATE 6

- Fig. 1. Phytomonas ananas sp. nov., on potato-glucose agar + 1 slant culture; 2-day-old, showing condensation water.
  - 2. Six-day-old slant culture, showing tear-drop ooze.
  - 3. Sixteen-day-old slant culture, showing abundant viscid growth; the greened medium in 2 and 3 is due to pigmentation. (All photographs by C. S. Angbengco.)



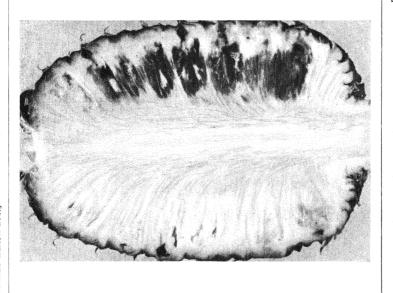


PLATE 1.

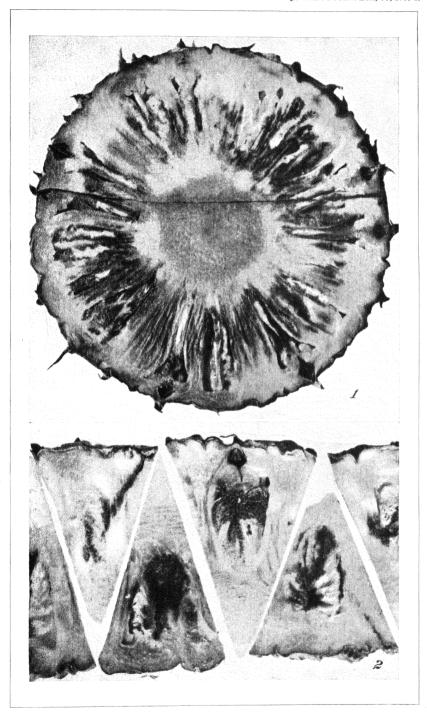
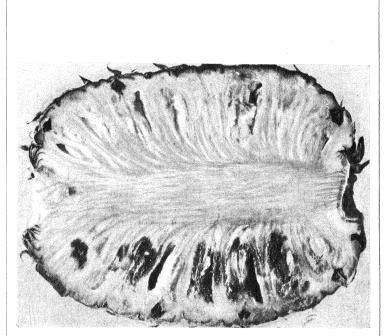


PLATE 2.



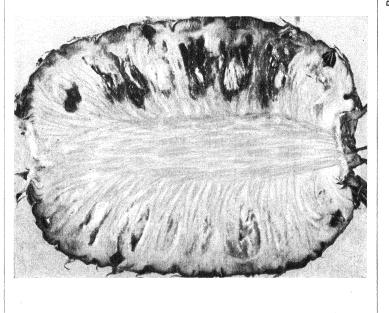


PLATE 3.

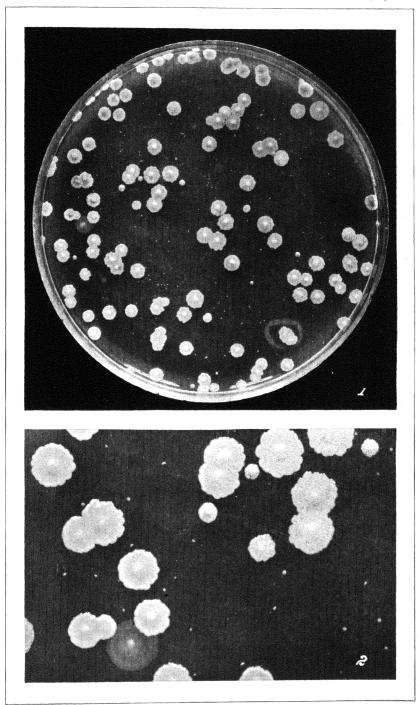


PLATE 4.

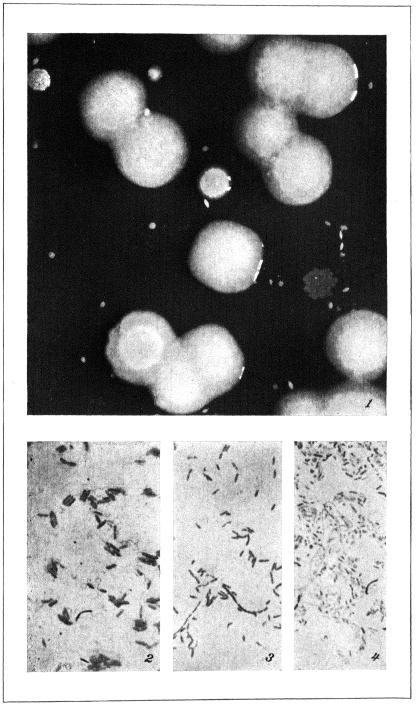


PLATE 5.

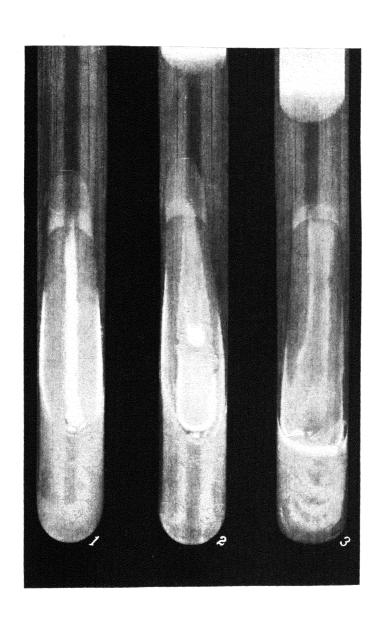


PLATE 6.

## PINEAPPLE MEALY-BUG WILT IN THE PHILIPPINES 1

By F. B. SERRANO<sup>2</sup>

Of the Bureau of Science, Manila

### FIVE PLATES

### INTRODUCTION

During the middle of 1927 the writer found a few Smooth Cayenne pineapple plants in a 1-year-old plantation at Calauan, Laguna Province, Luzon, suffering from "pineapple wilt." At the time the infestation was so mild that its possibility of becoming an important factor to reckon with in growing Smooth Cayenne pineapple seemed remote. About a year later, however, an entirely different aspect was presented by 2-year-old plantings belonging to the Philippine Packing Corporation in Makar, Cotabato Province, and in Santa Fe and Tangkulan, Bukidnon Province. Twenty to thirty per cent of both bearing and nonbearing plants were found collapsing from wilt. about the middle of 1929, the disease broke out with alarming severity in several hectares of young plants grown from Hawaiian planting materials in Santa Fe, and caused almost a complete collapse of the entire fields soon after (Plate 1, fig. 4). Plants grown from Bukidnon seeds, on the other hand. were quite free from the infestation (Plate 1, figs. 1 to 3). This rather serious situation attracted the writer's attention and prompted this investigation.

The pest was perhaps introduced many years ago with the importation of Smooth Cayenne plants from Hawaii. But despite its already long standing in the Islands according to information obtained from old local pineapple planters, nothing has

<sup>&</sup>lt;sup>1</sup> The second part of this paper dealing with the control measures will be published later in this journal.

<sup>&</sup>lt;sup>a</sup> The writer wishes to express his thanks to the Philippine Packing Corporation for the splendid coöperation extended him in supplying practically all the materials and labor used in conducting the experiments. He is also grateful to Dr. E. Quisumbing, of the National Museum Division, for reading the paper and for encouragement in its preparation.

been done or written here on the subject. In Hawaii, where most of the canned pineapples sold in the world market are grown, the first reference to wilt was made by Larsen, (7) in 1910. In 1912 Higgins (5) expressed the opinion that the damage caused by wilt was limited to a few fields. A few years later it became so serious, however, that Illingworth (6) reported it as being responsible for the failure of the entire crop in 1920. Since then the wilt problem has been considered the most serious factor the pineapple grower has to contend with.

Sideris and Paxton(9) in summarizing the literature on rootrotting fungi with respect to plant failure expressed the belief that the root-rot caused by the phythiaceous organisms was probably one of the important factors responsible for the pineapple disease generally known as "wilt." Contrary to this, Illingworth (6) advanced the opinion that the pineapple mealy bug, Pseudococcus brevipes (Ckll.), was responsible for the transmission of the wilt disease by feeding on healthy plants after it has fed on diseased plants. He also stated that green spotting is a characteristic symptom of wilt which could be inherited from mother plants by vegetative propagation. Opinions vary, then, as to the true cause of pineapple wilt. For this reason and in view of the fact that the malady assumes alarming proportions and is of tremendous economic importance, this investigation seemed warranted. Carter, (1,2) in 1933, published the results of his work on the same problem, which corroborate the present findings in practically all points.

### DESCRIPTION OF THE MALADY 8

"Wilt" is a general term which refers to that condition of a plant signifying flaccidity or lack of rigidity and freshness, with or without color changes in the affected tissues. In this particular case it is invariably associated with color changes, the extent of which depends somewhat on whether the wilt is of the "quick" or "slow" type. This "wilt" may be called "mealy-bug wilt" to differentiate it from "wilts" caused by other agents, like the phythiaceous fungi, (9) which are characterized by general wilting and yellowing of the leaves, accompanied by decay of the root system.

<sup>8</sup> This description is based on the results of artificial infestation experiments in order to tie up the types with their rather peculiar characteristics, which is not possible under field conditions.

#### QUICK WILT

This is the type of mealy-bug wilt resulting from a short period of feeding by a large number of mealy bugs. It usually occurs most prominently in young vigorously growing plants (Plate 2, figs. 1 and 2). In plants up to six or seven months old the tender leaves become pale, varying from very light dull green to pinkish or pale yellow. More characteristic than the color changes is the general loss of rigidity in the entire foliage, with the tender leaves becoming flaccid and bending outward. The tips of these leaves turn pale yellow, then become brown upon drying (Plate 2, fig. 2). The leaves of the inner whorls usually show green spots and may or may not have scattered small chlorotic areas with irregular margins (Plate 2, fig. 1). These two types of spotting (green and chlorotic) are usually seen on the same plant under field conditions.

With plants from nine to ten months old, there is a conspicuous reddening of the tender and medium-aged leaves. The outer leaves show either yellowish, pinkish, or yellowish brown color. Under field conditions, changes in color from pale green to pinkish or reddish shades are generally shown by plants widely spaced in the rows, while densely spaced plants show changes from pale green to yellowish or brownish shades, suggesting that light has some influence in the transformation. When quick wilt occurs at the flowering or fruiting stage, it results in a general yellowing or browning and drooping of the leaves, with the tips eventually drying up and showing welts with browned centers of secondary necrosis (Plate 3, figs. 1 and 2). As a result of this type of infection the undeveloped fruit may become "crooked-neck" and assume a more or less pendant position (Plate 3, fig. 1).

### SLOW WILT

Differing somewhat from the preceding is the slow wilt occurring after a small colony of mealy bugs has ultimately developed into a large one. This type of mealy-bug wilt is generally found among not-too-vigorously growing plants. The color changes in this type are comparatively few. Its most outstanding symptom is perhaps the large number of mealy-bug feeding points generally covering the entire surface and interfering with the proper functioning of the leaves. The spotting is usually of the chlorotic type, although some green spotting may also occur. The tips of the leaves turn brown and dry, those of the older leaves bending outward and drooping, but none of the yellowish

or pinkish coloration characteristic of the quick wilt is in evidence. The younger leaves become flaccid although remaining upright, of a pale green color, the edges reflexing inward (Plate 1, fig. 4, X).

In both types of the mealy-bug wilt the roots are more or less collapsed, dried up, and generally invaded by saprophytic organisms. They are otherwise normal.

### THE PINEAPPLE MEALY BUG AND THE WILT

The pineapple mealy bug, *Pseudococcus brevipes* (Ckll.), belongs to the order Homoptera and the family Coccidæ. It is parthenogenetic and viviparous. It develops rather slowly, two months at least being required by the youngest larva to develop into the gravid female. It is covered by a whitish waxy substance, which serves as a protection. It secretes honeydew, and has therefore almost invariably the attendance of two species of ants,<sup>4</sup> *Solenopsis geminata* Fabr. var. *rufa* Jerdon and *Pheidole megacephala* (Fabr.)

Fullaway(4) considered the insect to be partial to bromeliaceous and allied plants, and indigenous in Central and South America. In 1920 Morrison(8) reported it on pineapples and bananas in the Philippines.

On close examination hundreds of wilting specimens of 4- to 6-month-old Smooth Cayenne plants grown from Hawaiian planting material (mostly tops) during the early part of 1929 in Santa Fe, Bukidnon Province, were found infested more or less heavily by this insect, while apparently healthy-looking plants were practically free. Under field conditions the mealy bugs are mostly located on the tender parts of the leaves, generally in the crevices of the whorl. During sunny days they may be found all over the surfaces of the leaves, while during rainy days they usually congregate on the lower surface; in advanced cases of infestation they may penetrate as far down as the rootstock. These observations enhanced the suspicion that their presence has something to do with the incidence of pineapple wilt, hence the following experiments.

### EXPERIMENT 1: WHAT CAUSES PINEAPPLE WILT?

Materials and methods.—Thirty-five empty gasoline cans were opened on the top and on one of the sides. The opening was made by cutting close to the seam all around the top and leav-

<sup>&#</sup>x27;Identified by Mr. Fidel del Rosario, assistant systematic entomologist of the Bureau of Science.

ing an inch-edge all around the cut side. Against the open side was placed a 1/8-inch-thick glass plate cut to fit the inside dimension of the can. The cans were filled with steam-sterilized plantation soil and placed on a bamboo flat form with posts covered with Tanglefoot to prevent ants and other insect from getting into the cans. Each of the cans was then planted with a healthy Bukidnon Smooth Cayenne top previously cured for three weeks in the sun and treated for mealy bugs by soaking in 1.0 per cent hot (45° C.) soapsuds for 30 minutes the day previous to planting; later the cans were divided into seven uniform groups.

February 1, 1929, or three months after planting, the plants of the first three groups were infested with the pineapple mealy bug (*Pseudococcus brevipes*), by placing one gravid female on each of the first group (1 to 5), ten gravid females on each of the second group (6 to 10), and twenty gravid females on each of the third group (11 to 15), while the fourth group (16–20) was not infested at all, as check. August 1, 1929, the remaining three groups of plants of the same age were infested with new batches of mealy bugs, also from wilted pineapple plants, in exactly the same way as in the first three groups.

Results.—Bimonthly observations were taken on the condition of each plant in the different groups until maturity as presented in Table 1.

Discussion of results.—Table 1 shows that all of the plants individually infested with twenty gravid females of Pseudococcus brevipes three months after planting showed typical symptoms of wilt two and one-half to six and one-half months after infestation (Plate 4, fig. 1); that of those infested individually with ten gravid mealy bugs, seven succumbed in six to twelve months, while of those infested individually with one gravid mealy bug only two became wilted in fourteen months. The greater the number of insects that feed on the plant at a time, the quicker is the wilt produced, and the more devastating becomes its effect. This may explain why in a field both quick wilt and slow wilt may be observed. On the other hand, all of those (16-20) that were not infested at all, as check, remained normal till maturity. Apparently, then, Pseudococcus brevipes is primarily and really the cause of this type of pineapple wilt.

The plants that had more insects at the beginning showed very many more a few months later; but when the plants became badly wilted only a few were left. Those that had but one to start with were found with hundreds of them, literally covering the whole plants at the close of the experiment. This may perhaps be accounted for by the fact that the mealy bugs migrate to neighboring fresh material as soon as the host plants start wilting, and some of them may go down to the rootstock, especially during rainy days. Thus it is quite common to find under field conditions few or no mealy bugs on top of wilted plants while masses of them may inhabit the rootstocks.

TABLE 1.—Showing Pseudococcus brevipes as the cause of pineapple wilt.

[N, Normal; GS, green-spotted; W, wilting, typical; R, recovering; S, spindly; WF, wilted at fruiting; SF, spindly at fruiting; PRF, partially recovered at fruiting; NF, normal at fruiting.]

Group.	Plants.	Mealy bugs in each plant.	Condition of plants observed—								
			Apr. 2, 1929.	June 2, 1929.	Aug	.1, 1929.	Oct. 2, 1	929.	Dec. 1, 1929.		
1	• 1- 5	1	4N, 1GS	4N, 1GS	4N,	1GS	4N, 1G	S 4	1N, 1GS		
2	a 610	10	3N, 2GS	3N, 2GS	3N,	2GS	3N, 2W	2	2N, 3W		
3	a 11–15	20	2N, 3GS	2N, 3W	1N,	4W	5W		1R, 4W		
4	16-20	(°)	5N	5N	5N.		5N		5N		
5	b 21-25	1					3N, 2G	S 8	BN, 2GS		
6	ь 26-30	10					2N, 3G	S 2	2N, 3GS		
7	ь 31–35	20					2N, 3G	S 2	2N, 3W		
Group.		Mealy bugs in	Condition of	1-	Percentage of plants—						
	Plants.	each plant.	Feb. 1, 1930	0. Apr. 1, 193	10.	Wilted.	Re- covered.	Spind	ly. Normal.		
1	a 1- 5	1	4N, 1GS	4SF, 1WF.		20		8	0		
2	a 6-10	10	1S, 4W	1SF, 4W		80		2	0		
3	a 11-15	20	1R, 4W	1PRF, 4W		100	(20)				
4	16-20	(0)	5N	5NF	-				100		
5	b 21-25	1	3N, 2GS	2SF, 3NF.				4	0 60		
6	ь 26-30	10	2N, 3W	1	- 1	60		4	0		
7	b 31-35	20	5W	1PRF, 4W		100	(20)				

a Infested February 1, 1929.

Another feature noted aside from the chlorotic spots, as given in Table 1, is the production of green spotting on leaves of the majority of plants that wilted. The cause of this discrepancy among the wilted plants was not clearly understood. Hence, the mealy bugs present in all of the artificially infested plants were closely watched and examined as the experiment progressed in an attempt to correlate, if possible, their behavior and nature with the set of symptoms produced on their respective hosts. As a result, it was found that in plants where green spotting is present, the adult mealy bugs are of two colors, one

b Infested August 1, 1929.

c Check.

pinkish and the other grayish, whereas in plants where no green spotting occurs there is but one, the pinkish strain. The same thing was found to be true under field conditions. This fact would seem to be a clue to the solution of this phase of the problem. Following this line of evidence, another set of experiment was conducted.

### EXPERIMENT 2: WHAT CAUSES GREEN SPOTTING?

Materials and methods.—In order to determine whether or not the gray strain of the pineapple mealy bug referred to in the preceding experiment has anything to do with green spotting, the following experiment was set April 2, 1929. Fifteen potted plants were prepared in exactly the same manner as in Experiment 1, except that green spotted tops of Hawaiian Smooth Cayenne were substituted for the nonspotted tops of Bukidnon Smooth Cayenne. The plants were divided into three uniform groups. The first group (1 to 5) was infested individually with fifteen pink gravid mealy bugs, the second group (6 to 10) was left untouched, as check, while the third group (11 to 15) was infested individually with fifteen gray gravid mealy bugs.

Table 2.—Showing that gray Pseudococcus brevipes causes green-spotting.

[N, Normal; GS, green spotted; W, wilting, typical; R, recovering; WF, wilted at fruiting; PRF, partially recovered at fruiting; D, dead; NF, normal at fruiting.]

Plant group.	Mealy bugs in each plant.		Condition of plants observed—							Total percentage of plants—			
	Num- ber.	Color.	June 2, 1929.	Aug. 2, 1929.	Oct. 1, 1929.	Dec. 1, 1929.	Feb. 2, 1930.	Apr. 2, 1930.	June 2, 1930.	Wilted.	Green- spotted.	Recovered.	Normal.
1	15 15 15 15	Pinkdodo	N N N N	N N W N	N W W	N W W	W W R W	W W R W	WF D PRF WF D	100	0	20	0
11	(a) (a) (a)		N N N N	N N N N	N N N N	N N N N	N N N N	N N N N	NF NF NF NF	0	0	0	100
111	15 15 15 15 15	Gray do do do	GS GS GS GS	W W GS GS W	W W GS W	W W W W	R W W W	R W W W	PRF D WF D D	100	100	20	0

Results.—Table 2 gives the results of bimonthly observations made for seven consecutive times on every plant of each group.

Discussion of results.—It is shown in Table 2 that in about six months all plants infested by the gray mealy bugs developed green-spotting and typical wilt symptoms, while those infested by the pink mealy bugs showed wilt symptoms alone two months On the other hand, the check plants developed neither typical wilt symptoms nor green-spotting. No green spots besides those that they originally had before planting were found These results show that green-spotting at the close of the test. is caused by the gray mealy bug, and that green-spotting does not constitute an important character of pineapple wilt, inasmuch as typical wilt could be reproduced with or without green-spotting. Its occurrence appears to be purely incidental and inherent in the presence of the gray strain of the pineapple mealy bug. It seems certain, however, that wherever green-spotting is found in abundance wilting is fast and decisive. Green-spotting would appear, therefore, to be more closely associated with quick wilt than with slow wilt.

In the pink mealy-bug series the main feature, aside from the general wilting of the plants, is the presence of chlorotic spots on the leaves, which are generally of very variable size and irregular margin but may be circular and minute at times. Where large colonies have developed the leaves are more or less covered with such rugose, somewhat translucent, chlorotic areas with brown necrotic centers. Stained sections through these areas show degenerated chloroplasts, the thickening of the cell walls, and the absence of starch. On the other hand, in the gray mealy-bug series the outstanding characteristic in addition to general wilting is the prevalence of green-spotting as previously stated. These green spots, which at first appear as faint yellowish green homogenous spots, arise from the feeding point of the insects near the junction of the green and the white tissue at the proximal end of the leaf. Some of the green spots have a concentric zone of lighter green around the darker center. These eventually become green welts, which are slightly raised in older tissue and particularly conspicuous in chlorotic leaves that have dried and shrivelled as commonly found obtaining under field conditions. Stained sections through these green spots show neither degeneration of the chloroplasts nor thickening of the cell walls, as typically seen in the chlorotic areas, but reveal instead an increase in the size and number of the chloroplasts.

That the check plants showed no sign of wilt or new green spots up to the end of the experiment, despite the fact that they had originally green spots in abundance, disproves Illingworth's (6) claim that green-spotting is a typical wilt symptom which could be inherited from mother plants by vegetative propaga-The writer believes that green-spotting is a localized disturbance brought about by the toxic effect of the secretion produced by the gray strain of the mealy bug, which is probably chemically distinct from that of the pink strain. Comparative microchemical study of the feeding areas of these two strains should prove elucidating. This belief seems to be further strengthened by the fact that repeated isolations made from these feeding points—namely, green spots and chlorotic areas—so far failed to show that there is any specific microorganism associated with their occurrence.

During the course of the experiment it was found that the green-spotting strain establishes larger colonies in a shorter lapse of time than the nongreen-spotting strain, and that the former changes the feeding points on the leaf oftener than the latter. This being the case, it is not surprising to see plants infested by this green-spotting strain wilting quicker than those infested by the other strain.

Another feature observed is the change in color taking place during the life of the mealy bug. This change seems to determine the mealy bug's individual capacity for toxicity as it in effect determines its power of producing green spots. It was noted that both the gray and the pink gravid mealy bugs produce young of exactly identical pinkish color, which makes it next to impossible to differentiate one from the other until they become almost mature, at which stage the green-spotting strain turns gray, while the nongreen-spotting strain remains pink throughout.

It was also noted that the development of mealy-bug colonies in all of the cultures under control is not as rapid and vigorous as under field conditions where there is free attendance of the two species of ants, Solenopsis geminata Fabr. var. rufa Jerdon, and Pheidole megacephala (Fabr.), which feed on the honeydew secreted by the mealy bugs. In view of the fact that the rate of wilting of the pineapple plant depends a great deal on the number of mealy bugs that simultaneously feed on it, it is understandable that wilting of plants under the controlled experiments proved to be not as sudden as in the field.

### EXPERIMENT 3: RECOVERY FROM WILT

Materials and methods.—Pressed by the great need for planting material and the tremendous collapse due to wilt of several hectares of new plantings in Santa Fe, Bukidnon, it was decided to find out if wilting plants could be revived. August 1, 1929, thirty wilting plants showing uniformity in size, age, stage of wilting, and volume of mealy-bug infestation were collected and trimmed by pruning all top leaves as well as the butt and roots. They were then divided into two equal lots, the first lot treated with 1.0 per cent hot (45° C.) soap solution for mealy-bug control, and the second lot left untreated as check. Both were cured under the sun by piling them separately, butts up. After curing for five days five plants from each lot were planted singly as in the preceding experiments. In like manner the remaining twenty plants were planted singly in two batches of ten after curing for fifteen and thirty days, respectively.

*Results*.—Observations similar to those taken on the preceding two experiments were taken as shown in Table 3.

TABLE 3.—Showing recovery of wilted plants.

[GS, green-spotted; S, spindly; R, recovering; W, wilting, typical; SF, spindly at fruiting;

RF, recovered fully at fruiting.]

	Plants.		Length	Condition of plants observed—							
Group.		Treatment.	of curing.s	Oct. 1, 1929.	Dec. 1, 1930.	Feb. 193		Apr. 2, 1930.	June 2, 1930.		
			Days.								
1	1- 5	None	- 1	2GS, 3S	2GS, 3S	2GS,	3S 3	W, 2S	4W, 1S		
2	6-10	Soapsuds_	5	5S	2R, 3S	5R	5	R	5R		
8	11-15	None	15	2GS, 3S	2GS, 3S	s, 3S 2GS,		W, 2S	4W, 1R		
4	16-20	Soapsuds_	15	5S	3R, 2S	5R	5	R	5R		
5	21-25	None	30	2GS, 3S	2GS, 3S	2GS,	3S 3	W, 2R	3W, 2R		
6	26-30	Soapsuds.	30	5S	4R, 1S 5R		5R		5R		
Group.	Plants.	Treatment.	Length	Condition of plants observed—			Percentage of plants—				
a.oup.			curing.a		930. Oct. 2	, 1930.	Wilted	Re- covere	Spindly.		
			Days.								
1	1- 5	None	1	4W, 1S.	4W, 1	SF	80		20		
2	6-10	Soapsuds	_ 5	5R	5RF_	5RF		100	)		
3	11-15	None	_ 15	4W, 1R	1	4W, 1RF		20	)		
4	16-20	Soapsuds	_ 15	5R	5RF.			100	)		
5	21-25	None	_ 30	3W, 2R	3W, 2	RF	60	40	)		
6	26-30	Soapsuds	_ 30	5R	5RF_			100	)		

<sup>\*</sup> By curing is meant trimming and drying in the sun of planting materials before they are set in the soil to prevent spoilage.

Discussion of results.—Table 3 shows that all of the wilting plants when pulled up, trimmed and cured, and dipped in soap solution for mealy-bug control and then planted, could recover and produce healthy good-sized fruits; while those treated similarly but not dipped in soap solution continued to wilt, excepting one in the first group which became spindly, one in the third group, and two in the fifth group which fully recovered and bore healthy fair-sized fruits. These results seem to indicate that wilted plants could be revived by proper treatment; that freedom from the pineapple mealy bug is the key to a successful treatment, and that this could be attained fully by hot soapsuds treatment alone and partly by proper curing in the sun. The longer the material is cured the greater is its chance of recovery from wilt when planted. This has been demonstrated repeatedly by mass planting under field conditions (Plate 4, fig. 2). That this is so may be explained by the fact that it has been observed that under natural conditions the mealy bugs abandon wilting plants because of lack or insufficiency of suitable food; hence, the recovery of plants occasionally observed under field conditions. For the same reason, aside from want of shelter, they also abandon infested planting material that is undergoing the curing process.

All of the plants used originally had green spots in addition to typical wilt symptoms when planted; but during the course of their growth up to maturity, only four out of fifteen developed green-spotting—two in the first group, one in the third group, and one in the fifth group. Those that showed green-spotting when examined proved, however, to have gray and pink mealy-bug infestation, not having been treated with soapsuds at all, which simply indicates that the presence of the gray mealy bug is essential in the production of the green spots.

It may also be seen from the same table that instead of quick wilt as generally observed in previous experiments, slow wilt is the rule, appearing not earlier than eight months after planting and from which no recovery seems possible. This may be explained by the fact that the infestation started with comparatively small mealy-bug colonies on quite slow-growing plants. According to field observations and the results of Experiments 1 and 2, only simultaneous action of a large number of mealy-bug colonies on succulent, vigorously growing plants can produce quick wilt.

In confirmation of the results obtained from the two preceding experiments, it is definitely shown that Pseudococcus bre-

vipes is primarily and wholly the cause of pineapple mealy-bug wilt.

### EFFECT ON FRUITS

At harvest time when infestation is heavy the pineapple mealy bugs are found in large numbers on fruits, stems, and sometimes on slips. The fruits become unclean-looking primarily because of the presence of honeydew secreted by the mealy bugs which becomes moldy (Plate 5). Carter and Ito(3) have the following to say in concluding their report on the matter: "The results clearly indicate that the presence of mealybugs in large populations at the base of fruits considerably reduces the quality of fruit by rendering the basal slices unmarketable as well as increasing the number of culls due to leaking and fermentation."

### SUMMARY

- 1. A disease called "pineapple mealy-bug wilt" is described. It has been found in the Philippine Islands wherever the Smooth Cayenne variety is grown. It appears to be identical with the wilt reported from Haiti and Hawaii, whence it might have originated through the introduction here of planting material.
- 2. Pineapple mealy-bug wilt is characterized by a general wilting of the plant, with or without green-spotting on the leaves. It assumes a number of forms depending upon the age and succulence and vigor of the plant, as well as the size and time of the onset of the initial mealy-bug infestation. A large population at the onset of the initial mealy-bug infestation produces quick wilt, while a small number produces slow wilt. The younger and more succulent and vigorous the plant, the quicker it succumbs to quick wilt.
- 3. Infestation experiments have conclusively shown that pine-apple mealy-bug wilt is primarily and truly caused by the pine-apple mealy bug, *Pseudococcus brevipes* (Ckll.). The insect evidently secretes a nonliving toxic principle, which causes the wilting of the plant, producing typical wilt symptoms in about two months.
- 4. Plants affected by quick wilt may recover and produce small fruits, which are otherwise normal. Slow-wilt victims do not seem to be able to recover at all.
- 5. The abundance and general vigor of the mealy-bug colonies seem to be greatly favored by the attendance of two species of ants, *Pheidole megacephala* (Fabr.) and *Solenopsis geminata* Fabr. var. rufa Jerdon.

- 6. There are two strains of the pineapple mealy bug, the gray and the pink. The former produces green spotting which is not an important characteristic of wilt though very common among quick-wilt cases, while the latter produces chlorotic spots that are characteristic of the two types of wilt but more commonly met with in slow wilt. Both spots are the localized effect at the insect's feeding point.
- 7. The ability to produce green spots is inherited by the young from the parent gray mealy bug.

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## **ILLUSTRATIONS**

### PLATE 1

- Fig. 1. Three-month-old Smooth Cayenne pineapple plants free from wilt; about  $\times$  1/50.
  - 2. Eight-month-old Smooth Cayenne plants free from wilt; about  $\times$  1/50.
  - 3. Thirteen-month-old Smooth Cayenne plants free from wilt; about  $\times$  1/50.
  - 4. Thirteen-month-old Smooth Cayenne plants on the verge of collapse due to wilt. Plants in front are victims of quick wilt, while those marked with x are suffering from slow wilt; about × 1/50. (All photographs by F. B. Serrano.)

### PLATE 2

- Fig. 1. Four-month-old Smooth Cayenne plant suffering from quick wilt, showing green-spotting and chlorotic areas on top leaves; about × 1/5.
  - Six-month-old Smooth Cayenne plant affected by quick wilt; about × 1/6. (Photographs by C. S. Angbengco.)

#### PLATE 3

- Fig. 1. Fifteen-month-old Smooth Cayenne plant succumbing to quick wilt at fruiting, showing crooked-neck malformed fruit; about × 1/8.
  - Leaves from fig. 1, enlarged to show green-spotting and chlorotic areas caused by the pineapple mealy bugs' feeding; about × 1/2. (Photographs by C. S. Angbengco.)

### PLATE 4

- Fig. 1. Five-month-old Smooth Cayenne plants showing quick wilt in about two months as a result of artificial infestation with 20 gravid mealy bugs; about  $\times$  1/5.
  - Six-month-old Smooth Cayenne plants grown out of wilting stock by proper treatment; namely, curing and soapsuds dip; about × 1/20. (Photographs by F. B. Serrano.)

### PLATE 5

Fifteen-month-old Smooth Cayenne plant with immature fruit showing many mealy bugs. The plant looks normal despite the prevalence of the mealy bugs. This is a case in which the initial infestation started with a small colony; about × 1/6. (Photographed by V. Ferrer.)

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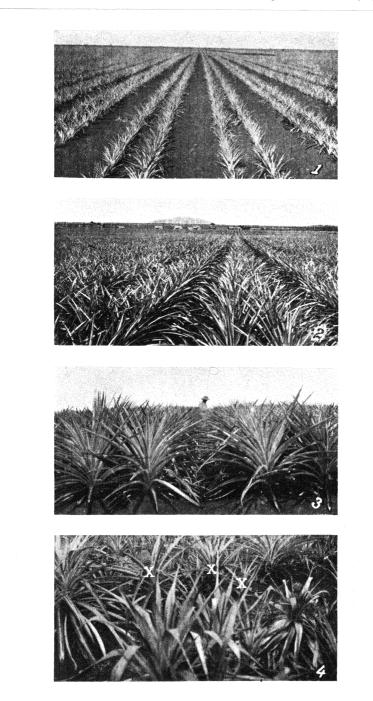


PLATE 1.

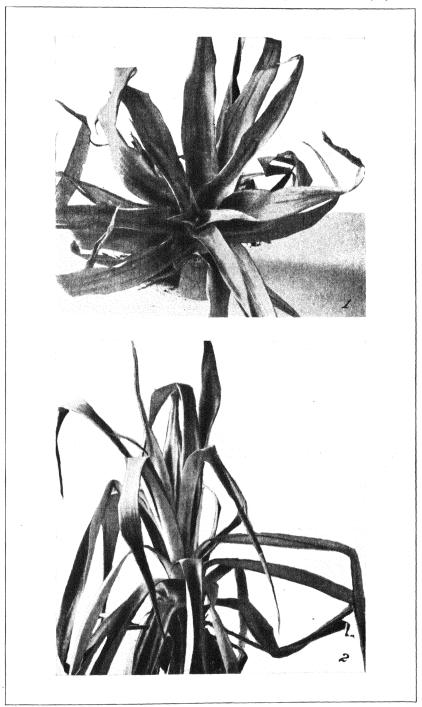


PLATE 2.

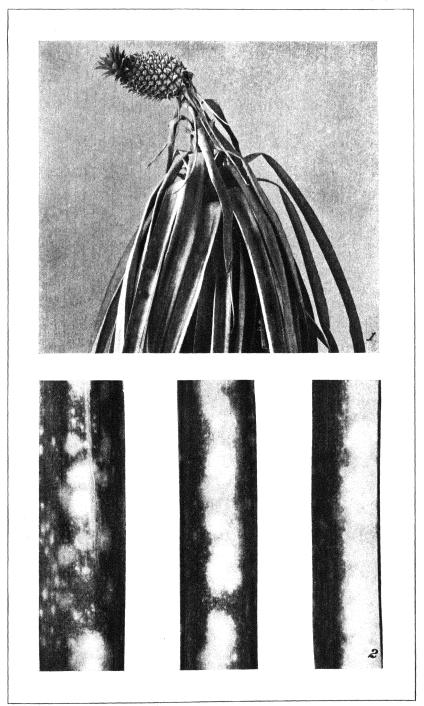


PLATE 3.

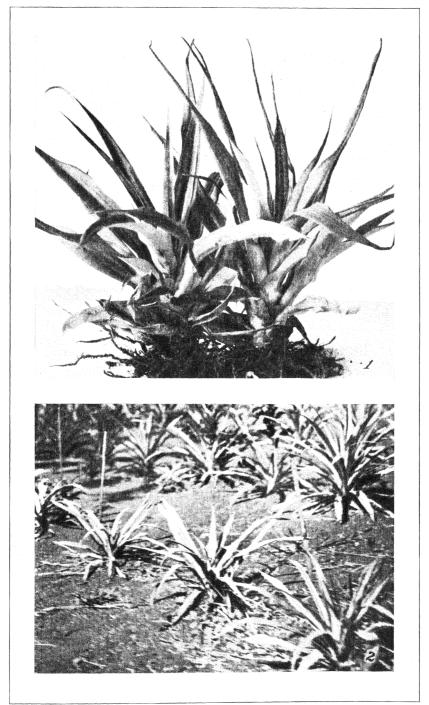


PLATE 4.

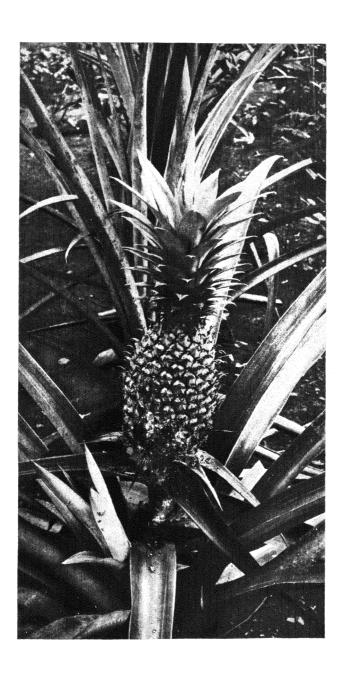


PLATE 5.

# NEW LONGICORN BEETLES FROM THE JAPANESE EMPIRE, II (COLEOPTERA: CERAMBYCIDÆ)

## By J. LINSLEY GRESSITT Of Tokyo, Japan

The present paper is the second of a series, the first of which appeared in the Pan-Pacific Entomologist.<sup>1</sup> The six species here described are from Japan, the Loochoo Islands, and Formosa, the material having been collected by Mr. M. Kato, Mr. Y. Yano, and the author. I am indebted to Dr. E. C. Van Dyke, Mr. E. P. Van Duzee, and Mr. M. Kato, for their coöperation.

### **CERAMBYCINÆ**

### Genus CERAMBYX Linnæus

CERAMBYX MINUTUM Gressitt sp. nov.

Minute, narrow, subparallel. Black, clothed with sparse golden-gray pubescence, which is sparser on head, prothorax, and first three antennal segments; tarsi brown, densely clothed with golden-brown pubescence, paler above.

Head slightly shorter than prothorax, rugulose, sulcate between the eyes and antennal supports, the sulcature dividing on frons, forming a broad Y; clypeus and labrum short; palpi reddish brown; eyes prominent, rounded, grossly faceted. Antennæ silvery; scape rugulose, twice as long as broad; second segment minute; third segment nearly twice as long as scape; fourth segment slightly longer than scape; fifth segment equal in length to sixth, seventh, eleventh, and second and third together; eighth, ninth, and tenth segments subequal, successively shorter; eighth segment equal to third; third segment swollen at apex, fourth less so; last three segments flattened. Prothorax long, narrow, rather slightly swollen in middle, slightly narrower than elytra at base, rugulose dorsally, with an unbroken mid-longitudinal ruga. Scutellum small, rounded, clothed with golden pubescence. Elytra narrow, parallel-sided, rounded at apices; surface even, minutely granulose; scales greenish gold, giving to the black surface a mouse gray appearance. Ventral surface evenly clothed with scales below, with a silvery-gold tinge. Legs grayish black, the pubescence giving a silvery tinge; relatively long, the femora rather thin; tibiæ four-fifths as long as femora; tarsi four-fifths as long as tibiæ; first segment of fore tarsi barely longer than second or third segments, first segments of middle and hind tarsi as long as second and third tarsal segments together. Last segment of hind tarsi, including claw, nearly as long as first segment.

Length, 12 millimeters; breadth, 2.25.

Holotype, a unique specimen, probably a female, in the author's collection, taken at Kamikochi, Japan Alps, altitude 5,000 feet, on the main island of Japan, in August, 1932, by Y. Yano.

### Genus EUSTRANGALIS Bates

### EUSTRANGALIS VIRIDIPENNIS Gressitt sp. nov.

Body straw-colored; elytra totally green, shiny; middle and hind tibiæ and tarsi nearly black, fore tibiæ lighter; eyes and posterior portion of head black, except for a narrow oval spot of dark straw color on occiput; anterior and posterior lateral and ventral margins of prothorax black; pronotum and scutellum entirely of a shiny dark straw color; antennæ variable; scape dark straw-colored, succeeding segments gradually darker, distal segments nearly black; ventral surface of body entirely straw-colored.

Body naked, except for short, sparse, golden hairs on elytra. Head very finely punctate; prothorax impunctate, glossy; elytra finely and evenly punctate. Antennæ reaching to apical fifth of elytra; scape slightly curved and thickened towards apex, as long as third segment; third segment one and one-half times as long as fourth; third and fifth equal; sixth and succeeding segments slightly shorter, subequal; third to fifth segments fine, thickened at apices; sixth to eleventh thicker, subcylindrical; apical segment blunt. Prothorax rounded at sides in middle, constricted before and after middle. Elytra with humeral angles slightly rounded; external and sutural angles of truncature toothed, the tooth of the external angle much more prominent. Ventral surface of body naked, glossy; sterna finely punctate.

Length, 15 to 16 millimeters; breadth, 3.5 to 4.

Holotype, female, No. 50565, United States National Museum, taken near Taiheizan, Formosa, altitude 5,000 feet, May 9, 1932; allotype, male, in author's collection, taken near Arisan, Formosa, altitude 7,400 feet, June 5, 1932; one paratype taken with holotype at type locality, and three paratypes taken at Arisan,

June 4 and 5, 1932; all collected by the author. Paratypes in the collection of Mr. E. Gorton Linsley and that of the author. Most of the examples were found on cut surfaces of logs, probably of *Chamaeocyparis formosensis*. The two specimens from Taiheizan have the elytra bluish green, instead of green, and the antennæ largely fulvous.

This species agrees very closely in structure with Eustrangalis distenoides Bates,<sup>2</sup> but is quite distinct. The latter has each elytron straw-colored and marked with a black longitudinal stripe from humerus to apex, instead of being green, and in having two black discal spots on the pronotum. Eustrangalis distenoides also differs in having the antennæ entirely black, the scape less curved and more angulate at apex, the tibiæ largely light-colored, and the last segment of the maxillary palpi dark. The elytra of E. distenoides are more attenuate, more sparsely clothed with hairs, and the humeral angles are more acute than in E. viridipennis. Furthermore, the last abdominal segment of the former is black.

### Genus STRANGALIA Serville

### Subgenus STRANGALINA Aurivillius

### STRANGALINA GRACILIS Gressitt sp. nov.

Similar to Strangalina attenuata (Linn.). Narrow, elongate; antennæ fine, legs long; clothed with short, dense, golden pubescence, very thin on abdomen; very distinctly marked with three elytral bands and two, oblique, longitudinal lines on pronotum.

Coloration tawny testaceous brown, nearly golden on elytra, marked with black in the following manner: Apical segment of each antenna, maxillary palpi, genæ, and eyes black; a transverse black band between eyes, interrupted at midline of occiput; a lateral black stripe on each side of neck, and two finer ones on ventral side; prothorax very narrowly margined anteriorly and posteriorly and striped laterally with black, disk marked with two narrow oblique lines approximate posteriorly and diverging anteriorly; scutellum black; elytra marked with three transverse fasciæ dividing the elytra into four subequal parts, the last the longest; suture and extreme apical tips black; lateral surfaces of meso- and metathorax partially black, metacoxæ and posterior third of each abdominal sternum black; apices of mesotibiæ, mesotarsi, posterior halves of metafemora and metatibiæ, and metatarsi black.

<sup>&</sup>lt;sup>2</sup> Linn. Journ. Zool. 18 (1884) 222, pl. 1, fig. 4.

Head long and narrow; surface very minutely punctate; from subparallel-sided, flat; neck abruptly constricted directly behind eyes; eyes globular, prominent, antennæ fine, posterior segments very slightly thickened, reaching slightly beyond middle of elytra, scape three times as long as thick, shorter than third segment and subequal to fourth and fifth, second segment shorter than broad, sixth and seventh subequal in length, and eighth to eleventh subequal. Prothorax longer than broad, twice as broad at base as at apex; sides nearly straight, very slightly swollen; external basal angles acute; base four-fifths as broad as base of elvtra: surface micropunctate. Scutellum small, triangular. Elytra long, narrow, slightly arched, straight-sided, clothed with very short golden and black bristles and very minutely punctate; apices narrow and subobliquely truncated. Ventral surface smooth, punctation nearly invisible; thorax pubescent; abdomen subglabrous, shiny, narrow. Legs long, hind femora reaching to elytral apices; tibiæ equal in length to femora; hind tarsi longer than femora or tibiæ; first segment of middle tarsi slightly shorter than remaining segments together; first segment of hind tarsi equal in length to remaining segments together; hind tarsi extremely narrow.

Length, 14 millimeters; breadth, 3.2.

Holotype, female, a unique specimen, in the author's collection, taken at Gusuku, Amami-Oshima Island, Loochoo Islands, July 10, 1932, by the author.

This interesting species is almost indistinguishable in markings and general appearance from the North American *Ophistomis luteicornis* (Fabr.), although it is more closely related in structure to the Palæarctic *Strangalina attenuata* (Linn.). *Ophistomis* is the New World counterpart of the subgenus *Strangalina*, but the two were considered as one by Aurivillius.

## STRANGALINA LONGICORNE Gressitt sp. nov.

Elongate, narrow; antennæ reaching to last fifth of elytra.

Head, thorax, and abdomen black; ventral surface of thorax and abdomen clothed with silvery brown pubescence; pronotum slightly pubescent; elytra clothed with very short, suberect, brownish-black bristles. Antennæ with the first seven segments and the apical segment black, eighth to tenth segments, inclusive, pale buff, clothed with pubescence of the same color. Elytra burnt ochraceous brown, having a varnished appearance with somewhat satiny reflections; each marked with a some-

what indistinct round black spot near the external margin at a point sightly before the middle; suture, external margins, and extreme apices black. Legs ochraceous brown, lighter than elytra; middle and hind tibiæ dark reddish brown, tarsi nearly black.

Head moderately long, broad across genæ, very narrow behind eyes, punctate, except on middle of frons; eyes prominent, subglobular; frons short, clypeus large. Antennæ long and thick, reaching to last fifth of elytra, scape only slightly thickened towards apex, slightly shorter than third segment, fifth segment longer than fourth, fourth subequal to sixth and seventh, eighth and ninth subequal, tenth and eleventh subequal. Prothorax long, narrow, three-fifths as wide at apex as at base, not swollen at middle, slightly constricted between middle and external angles of base, which are acute; base four-fifths as broad as elytra at base, surface finely punctate. Scutellum narrow and long. Elytra long, very narrow towards apices; surface finely punctate; apices obliquely truncate. Ventral surface of body smooth, satiny, very minutely punctate; abdomen long, segments narrow. Legs long, hind tibiæ longer than femora; first segment of middle tarsi slightly longer than remaining segments united; first segment of hind tarsi one-third longer than remaining segments united; hind tarsi as long as hind femora; hind femora lacking about three millimeters of reaching elytra apices.

Length, 16 to 18 millimeters; breadth, 3.4 to 4.

Holotype, female, No. 50566, United States National Museum, and one paratype, also female, in author's collection, taken at Gusuku, Amami-Oshima Island, Loochoo Isands, Japan, July 10 and 11, 1932, by the author.

### LAMIINÆ

### Genus MONOCHAMMUS Guerin-Meneville

### MONOCHAMMUS FILICORNIS Gressitt sp. nov.

Very similar to *M. bimaculatus* Gahan. Small, narrow, antennæ very long and fine. Mouse gray, mottled with pale fawn on elytra; each elytron marked with a round, satiny black spot slightly behind the middle and closer to the external margin; scutellum light brown; antennal segments basally annulated with light gray, which is lighter in the female.

Head narrow, impunctate, microgranulose on occiput, clothed with tawny gray adpressed hairs, sulcate between eyes; eyes

small, hardly reaching to middle of genæ, constricted almost into two parts behind antennal supports, fairly closely approximate dorsally; from narrow, convex, subrectangular, nearly square; genæ not prominent; clypeus short, amber-colored; labrum rectangular, dark brown, with several erect black hairs: palpi black. Antennæ very long; in male three and one-third times as long as body, scape long, three-fifths as long as third segment, cicatrix only moderately prominent, third to tenth segments subequal in length, eleventh segment three-fourths as long as body; in female two and one-third times as long as body. third to sixth segments subequal in length, seventh to tenth successively diminishing, eleventh segment as long as second and third combined. Prothorax cylindrical, slightly shorter than broad, very slightly broader basally than apically; surface fairly smooth, three slight raised points noticeable on disk in male; lateral tubercles very short, barely perceptible. Scutellum very Elytra nearly straight-sided, rounded posteriorly; punctate, more noticeably on anterior portion of disk; broadest at humerus, narrowed more in male. Legs short, gray; hind tarsi three-fourths as long as hind femora; first segments of middle tarsi noticeably shorter than the two following segments combined; first segment of hind tarsi considerably shorter than terminal segment. Ventral surface of body grayish brown with a thin pale buff pubescence.

Length, 12 to 14 millimeters; breadth, 3.5 to 4.

Holotype, male, No. 50564, United States National Museum, and allotype, female, and one paratype in author's collection, all taken at Horisha, Formosa, May 25, 1932, by the author.

This species, although very similar in markings and very closely related to *Monochammus bimaculatus* Gahan, of India, is more similar in form and proportions to *M. subfasciatus* Bates, of Japan. *M. filicornis* differs from *bimaculatus* in its smaller size, narrower body, much longer and finer antennæ, in having the elytral spots rounder and placed more posteriorly, and in being gray instead of a rusty color. Furthermore, in the former the prothorax is smoother, with the lateral tubercles much shorter, and the scutellum is decidedly of smaller proportion.

Schwarzer <sup>3</sup> doubtfully recorded this species as *M. bimaculatus* Gahan from a single imperfect specimen, and the error has

<sup>&</sup>lt;sup>8</sup> Ent. Blätter, 1925.

been perpetuated. This is the common species on the island, and M. bimaculatus is being absent from the fauna.

## Genus MELANAUSTER Thompson

## MELANAUSTER FLAVOMACULATUS Gressitt sp. nov.

Black, glabrous, marked with spots of dense, closely adpressed, pale yellow pubescence on scutellum, elytra, and posterior margin of metasternum.

Head black, minutely punctate; from squarish, medially grooved; eyes small, narrow; mandibles short. Antennæ black, onefourth their length longer than body; scape short, two-thirds as long as third segment, enlarged and rounded at apex, clothed with a few short bristles; remaining segments smooth and naked, nonannulated, except for third segment which is lightly pale at base; third segment slightly incurved at middle, one and onethird times as long as fourth; fourth one and one-fourth times as long as fifth; fifth to ninth subequal; tenth shorter than ninth; eleventh one and two-thirds times as long as tenth. shiny black, short, very finely punctate except on disk, very smooth, with only a single slight swelling near the middle of the posterior margin and a very shallow longitudinal groove along the dorsal midline; armed at each side with an obtuse, blunt, cone-shaped tubercle. Scutellum rounded, broader than long; entirely clothed with yellow pubescence. Elytra short, each four times as long as broad, parallel for most of their length. rounded at apices; smooth, glossy black, very minutely punctate; each marked with about twelve large, rounded, yellow spots. covering one-third of surface and placed in five transverse bands, some of the spots coalescing; the first band is of three round spots, the second, third, and fourth bands are of two spots each, the outer ones broader and meeting the external margin, the inner ones more or less near the suture, the last band is of three spots forming a triangle, one spot near the apex, one anteriorly adjacent to the suture, and the last small and adjacent to the external margin; the first band close to the base of elytra with the innermost spot adjacent to the scutellum, the second band close to the first, a broad space between the second and third bands, and the third band slightly behind the middle. tral surface of body black, thinly clothed with pale scales, which are thicker on posterior margins of first and second abdominal sterna, a pale yellow band on posterior margin of metasternum. Legs short, thick: thinly clothed with gray scales, thickest on tarsi.

Length, 23.5 millimeters; breadth, 8.5.

Holotype, a unique specimen, probably a female, in the collection of M. Kato, of Tokyo, and taken by him at Karapin, Formosa, August 19, 1923.

### JAPANESE NAMES OF NEW SPECIES

- 1. Cerambyx minutum sp. nov. Komiyama-kamikiri.
- 2. Eustrangalis viridipennis sp. nov. Aobane-hana-kamikiri.
- 3. Strangalina gracilis sp. nov. Oshima-hoso-hana-kamikiri.
- 4. Strangalina longicorne sp. nov. Higenaga-hoso-hana-kamikiri.
- 5. Monochammus filicornis sp. nov. Futamon-higenaga-kamikiri.
- 6. Melanauster flavomaculatus sp. nov. Kiboshi-gomadara-kamikiri.

## **ERRATUM**

## VOLUME 54

In the article by K. M. Heller, pages 279 to 307, the line at the side of each text figure, which is intended to show the actual size, should have been one-half as long as it is; in other words, the text figures are about twice natural size.

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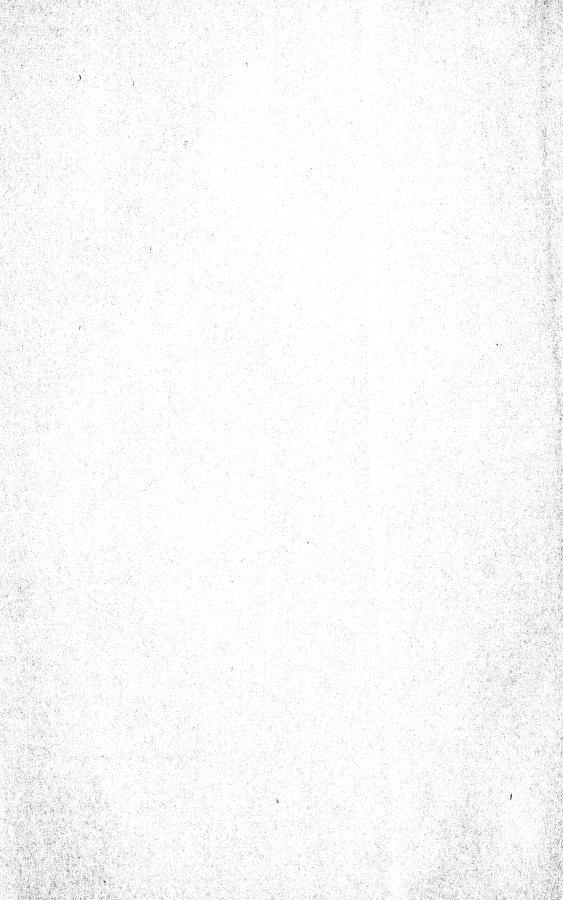
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